THIS BOOK IS INTENDED AS A SANITARY GUIDE ONLY AND MUST NOT BE QUOTED AS AN AUTHORITY FOR EQUIPMENT, SUPPLIES, ETC.

FIELD SERVICE SANITARY NOTES

INDIA

1919

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1919

AGENTS FOR THE SALE OF BOOKS PUBLISHED BY THE SUPERINTENDENT GOVERNMENT PRINTING, INDIA, CALCUTTA.

IN EUROPE.

Constable & Co, 10, Orange Street, Leicester Square, London, W C.

Kegan Paul, Trench, Trubner & Co., 68-74, Carter Lane, E.C, and 25, Museum Street, London, W C.

Bernard Quaritch, 11, Grafton Street, New Bond Street, London, W.

P. S King & Sons, 2 & 4, Great Smith Street, Westminster, London, S W

H. S. King & Co, 65, Cornhill, E C, and 9, Pall Mall, London, W.

Grindlay & Co., 54, Parliament Street, London, S W.

Luzac & Co., 46, Great Russell Street, London, W C.

W. Thacker & Co, 2, Creed Lane, London, E.C.

T Fisher Unwin, Ltd., 1, Adelphi Terrace, London, W C

Wm. Wesley & Son, 28, Essex Street, Strand, London.

B. H. Blackwell, 50 & 51, Broad Street, Oxford.

Deighton Bell & Co., Ltd, Cambridge.

Oliver and Boyd, Tweeddale Court, Edinburgh.

E Ponsonby, Ltd, 116, Grafton Street, Dublin

Ernest Leroux, 28, Rue Bonaparte, Paris

Martinus Nijhoff, The Hague, Holland.

IN INDIA AND CEYLON.

Thacker, Spink & Co, Calcutta and Simla.

Newman & Co., Calcutta

R Cambray & Co, Calcutta

S K. Lahiri & Co., Calcutta.

B. Banerjee & Co, Calcutta

The Indian School Supply Depôt, 309, Bow Bazar Street, Calcutta, and 226, Nawabpur, Dacca

Butterworth & Co. (India), Ltd., Calcutta.

Rai M C Sarcar Bahadur & Sons, 90/2A, Harrison Road, Calcutta

The Weldon Library, 18-5, Chowringhee Road, Calcutta

Standard Literature Company, Limited, Calcutta

Lal Chand & Sons, Calcutta

Higginbotham & Co, Madras

V. Kalyanarama Iyer & Co, Madras.

G. A Natesan & Co, Madras.

S. Murthy & Co., Madras

Thompson & Co, Madras.

Temple & Co, Madras.

P. R Rama Iyer & Co, Madras.

Vas & Co, Madras.

E. M. Gopalakrishna Kone, Madura.

Thacker & Co., Ltd, Bombay

A J. Combridge & Co., Bombay.

D B. Taraporevala, Sons & Co., Bombay.

Mrs Radhabai Atmaram Sagoon, Bombay

Sunder Pandurang, Bombay.

Gopal Narayan & Co, Bombay

Ram Chandra Govind & Son, Kalbadevi, Bombay.

The Standard Bookstall, Karachi

Mangaldas Harkisandas, Surat

A H Wheeler & Co, Allahabad, Calcutta and Bombay

N B Mathur, Supt, Nazir Kanun Hind Press, Allahabad

Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore and Allahabad

Rama Krishna & Sons, Lahore

Supt, American Baptist Mission Press, Rangoon.

Manager, the "Hitavada," Nagpur

S. C. Talukdar, Proprietor, Students & Co., Cooch Behar.

A. M & J Ferguson, Ceylon

Manager, Educational Book Depôts, Nagpur and Jubbulpore *

Manager of the Imperial Book Depôt, 63, Chandney Chauk Street, Delhi

Manager, "The Agra Medical Hall and Co-operative Association, Ltd. (Successors to A. John & Co, Agra)*

Supt., Basel Mission Book and Tract Depository, Mangalore *

P. Varadachary & Co., Madras *

H Liddell, Printer, etc., 7, South Road, Allahabad.*

Ram Dayal Agarwala, 184, Katra, Allahabad *

D C Anand & Sons, Peshawar.*

Manager, Newal Kishore Press, Lucknow *

* Agents for the sale of Legislative Department publications only.

In the compilation of this book the following works in addition to official Regulations, have been referred to :—

Post Office Guide, India, 1918.

Field Almanack, 1917.

F. S Notes for R. A. M. C. by Major T. H. Goodwin, R.A M.C.

Sanitation in War, by Major P. S. Lelean, C.B., R.A.M.C., 1917 Edition.

Memoranda on some Medical Diseases in the Mediterranean War Area, 1917 Edition.

Field Service Pocket Book, 1913.

The Extra Pharmacopæia, by Martindale and Westcott, 1915.

Memorandum, Treatment of Injuries in War.

Theory and Practice of Hygiene, by Notter and Firth 1908

Sanitary Law and Practice, by Robertson and Porter 1909.

Manual of Tropical Medicine, by Castellani and Chalmers, 1913.

Tropical Diseases, by Stitt, 1917.

Medical Entomology, by Patton and Cragg, 1913.

Indian Insect Life, by Lefroy, 1909, and pamphlet.

Practical Sanitation, by George Reid, M.D., 1903.

Modern Methods of Water Purification, 1911, by Don and Chisholm.

The Medical Annual.

Preventive Medicine and Hygiene, by Rosenau, 1917.

Publications by the Medical Research Committee.
British Medical Journal.
Lancet.
Military Surgeon.
Tropical Disease Bulletin.
Journal of Hygiene.
R. A. M. C. Journal.
Indian Journal of Medical Research.
Annals of Tropical Medicine and Parasitology.
Parasitology.

In many instances the author's words have been quoted verbatim : in others the substance has been taken and paraphrased to suit the requirements of this book. In no instances has it been possible, owing to the exigencies of the present situation, to obtain the consent of authors to make excerpts from their articles and it is trusted that this general acknowledgment will be accepted.

In Appendix II, Plates 1. 4 (i), 6 (2), 7, 12-14, 21 (2), 22 (1), 23 (2), 28 (1), 30, and 33-35 have been taken from Lelean's Sanitation in War.

Small numerals inserted in the text indicate references which will be found grouped at the end of each chapter.

Any errors detected in this book should be brought to the notice of the Director, Medical Services in India, and suggestions for inclusion in future editions are invited. Communications may be addressed direct

Medical Branch,
Army Headquarters, India.
June, 1919.

CONTENTS.

PAGE.

CHAPTER VII—*contd* PAGE.

CHAPTER VIII.

CHAPTER IX.

CHAPTER X.

CHAPTER XI.

CHAPTER XII.

APPENDIX I.

APPENDIX II.

TABLE OF ILLUSTRATIONS.

"Sanitation is a question of minutes and hours and not days, weeks or months."—*Maj.-Gen. W. W. Pike, C.M.G., D.S.O. and Lieut.-Col. A. Balfour, C.B., C.M.G., R.A.M.C.*

Field Service Sanitary Notes, India.

CHAPTER I.

SANITARY ORGANIZATION.

1. **Staff appointments, etc.**—In India, for operations on a large scale, the organization of Staff appointments will generally differ from that laid down in Regulations and handbooks. The difference lies in the greater proportion of specialist sanitary appointments rendered necessary by the size of the country and the magnitude of the sanitary problems that have to be contended with.

The Staff, etc., will normally consist of :—

Army Headquarters.

D. M. S.

A. D. M. S. (Sanitary).

D. A. D. M. S. (Sanitary).

Attached are :—

Sanitary Inspection Committee.

Certain Consultant Specialists (Chemist, Pathologist, Malariologist, Entomologist, etc.).

Army Corps.

D. A. D. M. S. (Sanitary).

Forces.

D. A. D. M. S. (Sanitary).

Divisions.

D. A. D. M. S. (Sanitary)

Brigades.

S. M. O.

Regiments or Units.

M. O.

Lines of Communication.[1]

A. D. M. S. (Sanitary). (Usually located at the base, and if at a large seaport, he may be aided by one or more Deputy Assistant Directors, Medical Service (Sanitary).

Divisional Areas.

D. A. D. M. S. (Sanitary).

SANITARY ESTABLISHMENTS ; DUTIES, ETC.

2. Sanitary Inspection Committee.[2]—Composed normally of a senior combatant officer as president with two or three specially selected medical experts, military or civilian, as members.

In practice, the senior combatant officer[3] should belong to the Royal Engineers, as many of the problems put before this Committee will be concerned with sanitary engineering.

Of their duties[4] the principal are :—

(i) To initiate important schemes of general sanitation and to serve as a board of reference for the solution of sanitary problems.

(ii) To ascertain what sanitary appliances and materials of all kinds are required for the army, and that an adequate reserve is maintained

At Ports of Embarkation another special Committee[5] assembles consisting of an officer of the brigade staff, a medical officer and a veterinary officer. Their duties are to survey the arrangements on ships, including the sanitary arrangements.

3. Consultant Specialists.—To co-ordinate (if a chemist) methods of purification of water and deal with chemical problems in connexion with water supplies, gas warfare, rations, etc. To investigate (if a pathologist) epidemic or new disease and advise as regards its control. To study local malarial conditions and advise as to the anti-malarial measures that should be enforced.

4. Sanitary Staff Officer.—Subject to such other instructions as they may receive, sanitary officers will [6]:—

(*a*) Exercise general supervision over the sanitary condition of all places occupied by the troops of the command to which they are attached.

(*b*) Watch the health conditions of billets, camps, bivouacs and posts, and at once investigate the cause of any unusual prevalence of disease among the troops *or the inhabitants.*

(*c*) Advise on the measures which should, in their opinion, be taken to protect the health of the troops, and report on the adequacy of the arrangements already made for that purpose.

(*d*) Advise on the selection, from a sanitary point of view, of sites for camps and bivouacs, and on questions relating to the sanitary condition of towns, villages or buildings about to be occupied. To this end they should accompany the staff officers charged with the selection of camps, billets or bivouacs.

(*e*) Advise regarding the purification and distribution of water for drinking purposes; also in respect of latrines and urinals, burial of the dead, and disposal of refuse and carcases of animals, etc.

(*f*) Impress on commanders of units and on medical officers in charge of troops the imperative necessity of attaining the highest possible sanitary standard, both in camp and on the line of march, and bring to the notice of superior authority any neglect of sanitary measures possible under existing circumstances.

At the base,[7] if a seaport, the sanitary officer is usually entrusted with the duties of port sanitary officer, with a view to preventing the introduction of infectious disease from transports; and will arrange for the segregation of cases of infectious disease and of contacts when considered necessary.

It is the duty of any staff officer[8] to give to the troops every assistance in his power in carrying out the instructions issued to them.

5. Sanitary Section.—The allotment in the British Army is one per Division.[9] In India, sanitary sections will be allotted

definite areas in which to operate, and will therefore be indirectly under the orders of the G. O. C. of the area. A sanitary section is essentially an area unit and is not intended to relieve any unit in that area of its own sanitary obligations, except in so far as it arranges for collective disinfection, water purification, etc.

It is divisible into sanitary squads[10] as required. It is usual, on the Lines of Communication, to provide a sanitary squad for each road or railway post, and two for each advance depot.[11]

Personnel.[12]

Medical Officer or junior combatant officer	1
British N. C. Os.	2
British men	8
Indian N. C. Os.	2
Indian men	12
Sweepers	60 (*a*)
Bildars	10
Bhistis	5
Private followers	3 (*b*)

(*a*) For work at a base as many more sweepers will be added as may be found necessary.

(*b*) 2 for O C. Unit and 1 for British N. C. Os. and men.

N.B.—A certain number of sweepers can well be replaced by followers of Labour Corps.

Equipment.

The revised equipment is given in full as Appendix I.

Transport.

The total weight for which railway transport is required is shown[13] as :—

Tentage	$24\frac{1}{2}$ maunds.
Baggage	$22\frac{1}{8}$,,

but note that as the equipment has recently been increased, the regulation weight for transport purposes is now 64 maunds 8 A. T. carts and 16 mules are authorised as a means of transport in the divisional area

6. Duties.—Sanitary Sections[14] are medical units whose duty is to safeguard the sanitary control of the various posts on the L of C. These units should be the first medical units to be mobilized, and they should be pushed rapidly forward with the first troops advancing, and be distributed at the base and at various posts as circumstances indicate.

On Ls. of C.[15] the general conservancy and sanitary measures at individual posts will be carried out by the personnel of the sanitary section allotted to that post, supplemented by such unit sanitary detachments or other fatigue men as may be required. The O. C. each post is responsible for the efficient conservancy and sanitation of his post on L. of C. and, in conjunction with the senior medical officer in the post, should make the fullest use not only of the unit conservancy or sanitary personnel present, but also of men belonging to the sanitary section allotted to the post. It will be sound policy to combine the whole of this personnel under the orders and direction of the S. M. O.

The duties of a Sanitary Section in war[16] are as follows :—

(*a*) Supervision of water-supplies, including their purification and distribution. [Apparatus and chemicals required for these purposes will be in charge of each section]

(*b*) Supervision of food supplies, cooking and slaughter places, and disposal of their waste water and refuse.

(*c*) Disinfection.

(*d*) Supervision of ablution places and disposal of waste water.

(*e*) Conservancy, refuse disposal and camp cleanliness, including that of animal lines.

(*f*) Sanitation of camps of hired transport, camp bazars, railway stations, camps and sites for troops passing through.

(*g*) Sanitation of routes between camps or posts, and the disposal of carcases, etc.

(h) Carrying out sanitary schemes which are beyond the power of regimental sanitary detachments.

(i) Acting as sanitary police.

It is of the utmost importance that sanitary sections should have everything in readiness before main bodies of troops, etc., arrive at the several camps.

The duties of a sanitary squad are given in more detail in Field Service Regulations.[17] As they act as sanitary police, the N. C. Os. and men are invested with the authority of military police and wear a badge A sanitary squad has, of course, no duties which a sanitary section will not perform.

The duties of sanitary sections or squads given in Regulations do not sufficiently indicate the fuller scope of the unit which modern warfare demands. It may be pointed out therefore that:—

(j) Where troops are encamped or stationed in collective units, experience has shown that water arrangements are best carried out by divisional or brigade authorities rather than by units. Normally this duty will be carried out by a sanitary section where one is allotted. Failing this, the division or brigade may constitute a special water unit by drawing on regimental water personnel: this should be placed under the supervision of one of the medical officers.

Where a sanitary section or squad is employed, the personnel in the first instance may be supplemented by such hired civilian labour as can be procured.[18]

Certain personnel should be wholly employed in making chlorine or bleaching powder solution, standardizing, bottling and labelling the same. The N. C. O. of the section or squad should inspect all water 'stations' in the area fortnightly or more often, checking the chlorination and sedimentation when these are in operation, advising on local improvements and reporting upon the efficiency of the personnel to his O. C. Similarly the O. C. should inspect the water arrangements of each unit in his area as a *routine;* and *specially* if water-borne disease is known to be prevalent or is anticipated as the result of movement of troops, etc.

(*k*) The laying-out of disinfecting stations, laundry and bathing arrangements will normally be undertaken by sanitary sections, with the co-operation of the Engineer Field Park (see section 179).

(*l*) The destruction of fly-breeding areas and the adult fly is an important duty for which fly sprays and fly baits, poisons, etc., will be specially provided.

(*m*) The O. C. sanitary section reports defects not under his immediate control to the M. O. of the unit concerned. It must be clearly understood that such reports should be verbal and tendered only in the spirit of co-operation. Should the sanitary defect continue, it is the duty of the O. C. section or squad to report the matter officially to his immediate superior, S. M. O., A. D. M. S. or O. C post, as the case may be. The latter should represent the matter immediately to the authority responsible for remedying the defect.

The area, for the sanitation of which the section is responsible, should be mapped out and the boundaries of sub-areas which are allotted to N. C. Os. should be clearly defined on the map. The position of sanitary defects should be flagged until remedied. Special care should be taken to prevent any area that has been vacated being left in an unsanitary condition.

(*n*) In open warfare, a mobile water section of the sanitary section (or Brigade sanitary water unit) should accompany the column and establish drinking water posts (small tanks, diggies) as near the advancing troops as practicable. These are kept filled from a water station established by the same water section during the advance. The water posts will be filled from pakhals carried on pack mules, or A. T. carts fitted with portable tanks, or by other methods.

The water section will either accompany the advanced guard or remain with the reserves until sent for as required by the Staff in co-operation with the sanitary officer. Troops passing these stations and posts will refill their water bottles and regimental pakhals.

This operation is of course simplified when trench or stationary fighting occurs.

(o) A War Diary will be maintained by the O. C sanitary section on Army Form C-2118 for submission monthly to the D. M. S. at General Headquarters through the usual channels. The latter will then transmit it to the officer in charge, A. G.'s office at the base. The diary will always be carefully safeguarded.[19]

7. Field Laboratories.—Laboratories will be formed at the base and advanced base.[20] No special establishment is provided for these in W. E. India, but laboratories will be allocated by the D. M. S. on mobilization where and when required.

8. Divisional and Brigade Provost Establishment—

Divisional Provost.[21]

British, 2 N. C. Os. and 10 men.

Indian, 2 N. C. Os. and 10 men.

Brigade Provost.[22]

British, 1 N. C. O. and 5 men.

Indian, 1 N. C. O. and 5 men.

The above units are composed of men withdrawn from units in the Division or Brigade. These men are under the command of the respective Provost-Marshal. Whilst the Provost-Marshal is not concerned with sanitation, his co-operation should be sought in a system whereby the police report locally to the S. M. O. sanitary defects and breaches of sanitary regulations.

9. Regimental Sanitary Establishment.—(i) *Regimental Sanitary Detachments.*[23]—One N. C. O., and 8 men provided by the battalion, are employed under the orders of the regimental M. O., or subordinate in units where a medical officer is not provided.

Duties.[24]

I. A. O. No. 708 of 1910 gives the duties of the detachment as :—

(a) Supervision of water-supplies including their protection, purification and distribution. [Apparatus and chemicals required for these purposes will be in charge of each detachment.]

(*b*) Supervision of food supplies, cooking and slaughter places of their units and disposal of waste water and refuse.

(*c*) Disinfection.

(*d*) Supervision of the ablution places of their units and disposal of this waste water.

(*e*) Conservancy, refuse disposal and cleanliness of their camps including that of the animal lines.

(*f*) Acting as sanitary police.

During an action the regimental sanitary detachment will assist the stretcher bearers of the unit in the removal of the wounded and dead.

The M. O. of the unit will allocate the various duties amongst the men composing the sanitary detachment, remembering that men employed on water duties should on no account do duty in connexion with latrines, handle infected clothing, or be brought in contact with the sick [25]

(ii) *Water Supply Personnel.*[26]—1 N. C. O. and 4 men per battalion, 1 N. C. O and 3 men per cavalry regiment (N. C. O. = corporal or naik) and 2 men per Field Company, Divisional Signalling Company, etc , provided by the unit, are specially employed on water duties.

Duties.[27]

The duties of the water supply personnel are :—

(*a*) The daily supervision of water supply, and its purification for drinking purposes by boiling, filtration or the addition of chemicals, as may be directed.

(*b*) To take charge of all apparatus and stores connected with the water supply of the unit.

These duties appear to overlap those given above for the Regimental sanitary detachment. In reality they are connected with the more specialized work of water purification, and in forces under War Office regulations are performed by attached R. A. M. C men.[28]

(iii) *Additional Water Supply Personnel.*[29]—8 men per battalion (2 men per company or corresponding unit) may be provided,

on requisition by the M. O., for the purposes of special work connected with water supplies.

N.B.—These men should be returned to the ranks when their special duties have been carried out.

(iv) *Sweeper Establishment.*[30]—8 sweepers per British or Indian cavalry regiment and infantry battalion and 5 per Field Company are allotted.

Officer in Medical Charge of a unit.

10. Books.—The following books are in the possession of M. Os. in peace[31] :—

	R. A. M. C.	I. M. S.
A. R. I. Vol. 2	1 (*a*)	1 (*a*)
A. R. I. Vol. 6	..	1 (*a*)
F. S. R. Part 2	1 (*b*)	1 (*b*)
F. S. R. Part 2, Ind. Sup. .	1 (*b*)	1 (*b*)
War Establishments, India .	1 (*b*)	1 (*b*)
Mob. and Conc. Regs., India .	1 (*b*)	1 (*b*)
F. S. Man. Med. Services .	1 (*b*)	1 (*b*)
Medical Manual War, India .	1 (*b*)	1 (*b*)

(*a*) by purchase.

(*b*) provided by the State.

In war, all 'service' books will be taken.[32]

In addition to the above it is desirable to possess the following :—

Field Service Sanitary Notes, India.

Field Service Pocket Book.

A list of books, forms and stationery which should be in the possession of each medical unit is furnished in "Tables of Books, Forms and Stationery taken into the field by the Army in India," page 74 *et seq.*

It may be noted that a small library of medical and surgical literature is maintained by O. Cs., British and Indian General Hospitals.[33]

11. Sanitary Duties.—The sanitary duties of an officer in medical charge of a unit are those concerned with:—

Rations and Stores.—Their quality, state of preservation, variety and cleanliness. Storage in fly-proof receptacles.

Cooking.—Distribution and method of cooking, etc.

Cooks.—Health, cleanliness, clothing, infectivity.

Cooking Utensils.—Method of cleansing; state of tinning; disinfection and cleansing of tables, chopping blocks, grease traps, etc.; provision of clean jharons, etc., where possible.

Water.—Source, sufficiency of supply, purification (chlorination, etc.), storage, distribution. Periodical cleansing of tanks, carts, pakhals, chatties and water-bottles.

Aerated Waters.—Sources of water, chlorination, cleanliness of bottles, strainers, brushes, etc.

Ice and Milk.—Supply, etc.

Disinfectants.—Adequate supply of bleaching powder, potassium chlorate, potassium permanganate, alum, cresol, crude mineral oil and insecticides including Vermijelli, N. C. I. powder sodium arsenite and formalin.

Conservancy.—Disposal of night soil, urine, sullage water, rubbish, slaughter-house offal and organic refuse. Inspection of every latrine, incinerator, refuse pit, grease trap, soakage pit and urine pit periodically. Anti-fly crusade; use of poison traps, tanglefoot. Anti-malarial measures.

Fitness of troops and followers.—Keep in touch with the individual generally and in particular with his medical history. Constant supervision of diet with particular reference to beri-beri. and scurvy amongst Indians; clothing; provision of exercise and mental recreation during periods of rest and tedium; adequate accommodation; ventilation; disinfection of tents and clothing; and care of personal hygiene—in particular of the teeth to combat pyorrhœa alveolaris; of the body to prevent vermin infestation. Watch the 'nights in bed.'

Disease.—Study the previous history of the unit, its sick ratios, the state of prophylactic inoculation against enterica, plague, cholera. Inoculate in the evening for preference and enter at once in Pay Books the date, vaccine and amount (see section 436). In infective diseases—prompt action in notifica

tion, isolation, and treatment of contacts and clothing. For general prophylaxis in an outbreak of Cholera, see under Cholera, sections 277-280.

12. The line of march.—*Time of marching.*—In hot weather start in the early morning so as to arrive not later than 9 A.M.

Night marching.—Where possible, discourage this as the soldier does not get his sleep. Tactical considerations may however outweigh both the above points.

The average length of march per diem is usually 12-15 miles and is carried out not faster than 3 miles per hour, excluding the half-way halt.

Clothing.—Shirts and jackets open at front and helmet worn correctly and not back to front. An abdominal binder (puttee) when worn, should be used at night only.

Water Supply.—During halts, from water carts or mule pakhals.

Halts.—5-10 minutes are allowed after the first half-hour's marching to allow of re-adjustment of puttees and equipment, and after each hour's marching thereafter. 15 minutes should be allowed at the mid-way halt. Longer halts are undesirable for physiological reasons.

Conservancy.—During the halts this is of the utmost importance. Failing the preparation of trenches in advance by a sanitary section or squad, the regimental sanitary detachment is responsible for the provision of proper trenches which must be filled in by the sweepers before departure, and marked for avoidance by following troops.

Heatstroke.—Precautions must be taken in summer; ample water supplied and, when possible, ice. See Heatstroke, section 320.

Rations.—It is as well to remember that the iron rations will never be touched unless no other rations of any kind are available, and then only by order of a commander.[34]

13. Arrival in Camp.—Supervise the work of the sanitary personnel whose duties in this connexion are as follows[35] :—

The provision of—

(i) A sufficiency of latrines for one day for (*a*) officers, (*b*) non-commissioned officers, and (*c*) men,

(ii) A urinal for (*a*) officers, (*b*) non-commissioned officers and (*c*) men.

(iii) A series of urine pits at the end of the lines for night purposes or a urine pit to receive the contents of the night urine tubs if they are used.

(iv) The necessary drains and pits for the disposal of waste water.

(v) Straining-pits or traps for greasy water, namely, one for each cooking place, one for the serjeant's mess (when established) and one for the officer's mess.

(vi) Such refuse pits or incinerators as may be needed.

(vii) Drains for carrying off excess water from stand-pipes (if these are provided), and around ablution or washing places.

In addition examine the slaughter places, arrange for the disposal of litter from mule and horse lines and their drinking water supply. Demarcate bathing establishments for men and animals. Whenever practicable latrines should be ready for immediate use on the arrival of troops.

14. Care of the feet.—The commonest defects in boots causing sore feet are insufficient vertical space for the toes, and lack of sufficient curve at the back of the heel to prevent vertical friction between the heel and the boot. The boot should be fitted over two pairs of socks to allow for swelling of the feet when marching.

Water-proofing and pliability should be secured by filling boots with oil (castor oil or cod-liver oil) for 24 hours. Excess of oil can be removed, after thoroughly draining, by filling the boots with dry bran.[36]

Daily washing of the feet, application of alum, spirit, dusting powders containing salicylic acid, are good preventive measures for blistering. Socks taken off should be dried, stretched and worn on the opposite feet next time. Badly darned socks should not be worn. The wearing of two pairs of socks on the march or the soaping of the inside of a single pair has often been recommended. The former is uncomfortable and necessitates socks of two different sizes being provided.

For sore feet when marching, advantages are claimed for a strap which can be fixed in a figure of eight round the boot

and ankle. When a man develops a blister or rubbed foot he puts on the strap which fixes the boot, prevents further rubbing, and changes the points of contact where there is pressure. It is claimed that marching can be continued without pain and the constriction of the superficial blood vessels tends to aid the healing of the blister.[37]

Early attention to boot bites, blisters and ulcers on arrival in camp is most essential. Blisters should be pricked with a clean needle at the lowest part and afterwards kept clean. Chafes require powder or a greasy ointment.

Wet boots should be dried by stuffing with dry grass, oats, straw or paper but not put near a fire. If filled with oats, the latter swell and prevent shrinkage.

The pulling-on of a wet boot is facilitated if a piece of lighted paper is first dropped into it and allowed to burn itself out. It does not hurt the wet boot but causes a film of steam inside which acts as a lubricant.[38]

15. Responsibility for Sanitation.—The responsibility for sanitation rests with the Commanding Officer in every instance.[39]

The Medical Officer, unless himself a C. O., is the sanitary adviser to the C. O. and it is his duty to bring to the notice of the C. O. all sanitary defects and recommendations.[40] His only executive command as a regimental medical officer is with the regimental sanitary detachment, for the efficient performance of whose work he is responsible to the C. O.[41]

16. Sickness on active service.—On active service, even under favourable conditions, the wastage from sickness is considerable; the sick admission rate increases when compared with cantonment life owing to the quality and quantity of rations and water supply being difficult to maintain, the greater physical strain imposed on troops, and the altered conditions of environment.

Enteric fevers, dysentery and diarrhœa tend to become much more prevalent. Deficiency diseases such as beri-beri and scurvy, almost unknown in peace, are to be expected when the rations are ill-balanced or deficient as the result of difficulties of supply or transport. Depending on the theatre of operations, malaria and sandfly fever may prove veritable scourges.

All the above are theoretically preventible diseases, and the principal means of combating them are effective sanitation, consequently 'a knowledge of sanitation and of the best means of preserving health is incumbent on every officer and soldier.'[42]

REFERENCES.

[1] F. S. R. II, 85(7).

[2] F. S. R. II, 86. • F. S. Pocket Book; Sect. 40(7).

[3] R. A. M. C. Training, Sect. 153.

[4] R. A. M. C. Training, Sect. 153.

[5] Mob. and Conc Regs. para. 200; A. R. I., Vol. X, paras. 116, 117.

[6] F. S. R. II, 83(4).

[7] F. S. R. II, 85(7).

[8] F. S. R. II, 14 (2).

[9] War Establishments, 1914 Expdy. Force.

[10] F. S. R II, Indian Sup. 46(2).

[11] F. S. Pocket Book, Sect. 40(6).

[12] F. S. Man. Med. Services, page 49; W. E., India, page 203. I A. O. No. 708 of 1910.

[13] F. S. Man. Med. Services, India, Sect. 6-B, page 123.

[14] Med. Man. War, India, Sect. 10-A.

[15] Med. Man. War, India, Sect. 29(6); F. S. R. II, 85(2) (3) (4) (5).

[16] I. A. O. No. 708 of 1910.

[17] F. S. R. II, 85(6).

[18] F. S R. II, 85(1).

[19] F. S. R. II, 140(3).

[20] F. S. R. II, 96(2).

[21] W. E , India, page 36.

[22] W. E., India, page 40. F. S. Manual Hd. Qr. Units, India, Table G(2).

[23] A. R. I., Vol II, para. 893C; I. A. O. No. 708 of 1910, para. 2.

[24] F. S. R. II, 84(4).

[25] R. A. M. C. Training, sect. 144.

[26] F. S. R. I, 46(3); F. S. R. II, Indian Sup. 46(1); W. E. 1914 Expdy. Force.

[27] F. S. R. II, 84 (3).

[28] F. S. R. I, 46(3).

[29] F. S. R. I, 46(4).

[30] W. E. India, 1916.

[31] I. A. O. No. 415 of 1914.

[32] Mob. and Conc. Regs. India, para. 83.

[33] Mobilization Store Tables of B. G. H. and I. G H.

[34] F S. R. II, 47(2).

[35] Manual of El. Mil. Hygiene, 56(3).

[36] Lelean's Sanitation in War, page 24.

[37] I. A. O. No. 116 of 1913.

[38] F. S. Pocket Book, Sect 6,(21) ; Field Almanack 1917, pages 36 and 41.

[39] F. S. R. I, 46(1) ; F. S. R. II, 83(2), 84(1) ; K. R. para. 99. Med. Man. War, India 29(1) ; A. R. I., Vol. II, para. 432, 878 ; Cantonment Code, Sect. 69.

[40] F. S. R. II 83(3) ; Med. Man. War, India, Chap. II, 4(1). A. R. I., Vol. VI. paras. 38, 71

[41] F. S. R. II, 84(2).

[42] F. S. R. II, 83(1).

CHAPTER II.

WATER SUPPLIES.

17. Water supplies on active service will be obtained from :—

(*a*) Wells.

(*b*) Rivers, streams.

(*c*) Lakes.

(*d*) Springs.

(*e*) Tube borings.

(*f*) Sea or brackish water by condensation (rarely), as at Aden.

18. Wells.—The ideal well for providing a pure drinking water is one which is sunk below an impermeable geological stratum; is wet steined, *i.e.*, lined with stone or brick, set in concrete or cement and carried above the surface; is covered by a dust and water-proof cover; provided with a coping or sloped platform to prevent washings flowing back into the well; is fitted with a pump in preference to a Persian wheel; and is of sufficient depth to ensure thorough sedimentation and a good quantity of water.[1]

The average Indian or trans-frontier well fulfils few, if any, of these requisites. The above furnish the measures to be aimed at in improving wells as sources of water supply. In addition, as a general working rule, no well should be selected that has an insanitary area likely to prove a source of contamination to the well water, within a minimum radius of 30 feet. A better way to estimate the danger zone is to discover the depression in feet caused in the well water by vigorous pumping for one hour, and this multiplied by 150 will give the radius of the danger zone in feet. These data must obviously be read in conjunction with the ground slope, direction of flow of sub-soil water, porosity of the soil and the speed of pumping.

19. Rivers, streams.—Except where arising directly from snow mountains above the limits of human habitation, all rivers and

streams in India may be held to be grossly contaminated, owing to the deliberate use of them as means of sewage disposal from habitations on their banks.

Some rivers, notably in trans-North-West Frontier regions, are brackish and even have a purgative effect. In addition such waters, if passing through the enemy lines, may be intentionally poisoned.

20. Lakes.—Generally speaking, lakes are better oxygenated than rivers and streams, and are therefore freer from organic matter. They are, however, particularly liable to fæcal contamination by cattle, which may not always be within sight.

21. Springs.—Many springs are merely the re-appearance of upland surface water that has temporarily passed underground, in which case the flow is often intermittent.

Until it has been ascertained that a spring is the first appearance of water arising from an underground reservoir lying between two impermeable strata, its purity must be viewed with grave suspicion.

Springs can sometimes be produced by driving tubes, bars or wedges into known water-bearing seams in hills or massif.

22. Tube-borings.—To establish an artesian well (where the water flows naturally) or a tube-well (where pumping is required) is a work of some magnitude. The difficulties lie in the apparatus required for construction, the uncertainty that water will be found, and when found that it will be suitable. Such waters when tapped are often disappointingly brackish or heavily charged with magnesium salts.

With Norton's tubes, where pumping is required, water cannot be raised above 25 feet. The normal rate of penetration in boring is only 10 feet per hour and moderately hard rock may prove a complete obstruction. An alternative to pumping is to provide a small pressure tube alongside the main shaft and force air into this.

The best sites for trial borings are—in hilly districts, the base of the steeper side of a deep valley, just below the point at which the valley bifurcates; in a plain, at the lowest depression, points where vegetation is greenest, where the morning mist hangs longest or where midges are most numerous. In dry *chohs* or sandy *nalas*, which during the monsoon period become streams

or rivers, water may often be found by boring or even excavating to a shallow depth. In the latter event the construction of a pit in the bed of the stream with a sloped approach provides a convenient method of watering animals.

23. Condensed water.—Such a water is of course bacteriologically pure, but not being aerated is somewhat unpalatable.

24. Water requirements.—The following are the water requirements of a military force :—

(*a*) Each man requires daily—

	Gallons.
In barracks, in the plains—	
British	20
Indians	8
In barracks, in the hills—	
British	15
Indians[3]	5
In standing camps, when clothing is washed[4]	5
In camps, when clothing is not washed[5] .	3
In bivouacs, for drinking and cooking only [4]	1 gallon.
For drinking only, as a minimum in India	4 pints.

(*b*) Each animal requires daily—

	Gallons.
Horse[3] ($1\frac{1}{2}$ gallons at a time[6]) . . .	10
Camel	10
Ox ($1\frac{1}{2}$ gallons at a time[6]) . . .	8
Mule ($1\frac{1}{2}$ gallons at a time[6]) . . .	5
Sheep	2
Pig	2
Elephant[6]	25

(*c*) Mechanical Transport requires daily—

For washing down at Field Parks . .	50
For radiator, filtered water, average . .	4

25. Estimation of yield.—(*a*) *Well* (circular).—The depth × square of diameter × 4·89342325 = gallons of water, if measured in feet. 1 cubic foot of water = 6·2305 gallons = 62 305 lbs. weight.

For the daily output, the rate of inflow must be found by lowering the depth rapidly by pumping, and noting the time taken to rise again over a measured foot.

(*b*) *Stream (medium)*.—Select 12 or 15 yards where the channel is uniform and there are no eddies. Take the breadth and average depth in three or four places. Drop in a chip of wood and find the time it takes to travel, say, 30 feet.

This gives the surface velocity in feet per second. $\frac{4}{5}$ths of this = the mean velocity. Multiplied by the sectional area, the yield per second in cubic feet is given.[7]

(*c*) *Stream (small)*.—Cut away the bed of the stream, *nala* or spring so as to form a miniature waterfall and estimate the time taken to fill a bucket, or 100 gallon tank.

26. **Examination of water and its source.**—Three methods are employed, each having its own importance:—

(1) Inspection of the source.

(2) Chemical examination.

(3) Bacteriological examination.

As regards *inspection* it cannot be impressed upon troops too often that the *appearance and taste of waters afford no warning of contamination*. In fact, waters that are moderately contaminated are frequently the most palatable and sparkling. The inspection of a water source may, however, afford valuable indications of the purity of the water. Generally speaking, inspection is more apt to lead to condemnation than to the supply being accepted. A stream ostensibly pure at the camp site, when inspected for a mile or so upwards, will often reveal gross contamination by the presence of habitations, manure heaps, drainage from cattle sheds, etc., on its banks, or it may even be found to run through the middle of a cholera-stricken village.

As regards *chemical examination*, a full analysis will rarely, if ever, be found necessary in the area of operations. Estimation of chlorine content, and possibly nitrites, will occasionally be found useful as, when these figures are excessive, a valuable indication of recent pollution is afforded, except where the water is naturally saline (*cf.* many North-West Frontier rivers and the salt-bed region of the Punjab). A high saline content

is deleterious apart from the question of excretal contamination and a high albuminoid water will interfere with chlorination.

As regards *bacteriological examination*, in times of epidemic water-borne disease, supplies require careful and thorough investigation. As a *routine* measure, however, water supplies in use or being selected will not be subjected to a full bacteriological examination. The points for determination usually valuable are:—

(*a*) The total bacterial content, and of this

(*b*) the proportion of lactose fermentors or organisms of the B. coli group; the assumption being made on service that the bulk of these are of excretal origin.

A definite conclusion can often be arrived at in 24 hours as to which are the best and which the worst of alternative sources of supply.

Such examinations are of a specialist nature and become the duty generally of.—

(*a*) The officer in charge of the water section of the sanitary section.

(*b*) The officer in charge of the Field Laboratory.

(*c*) Occasionally the D. A. D. M. S. (Sanitary) when he has access to laboratory equipment.

27. Water Purification.—The points aimed at in water purification are to eliminate·—

(*a*) Suspended matter.

(*b*) Deleterious salts in solution.

(*c*) Bacteria.

It may be said at the outset that the elimination of deleterious salts in solution is a very difficult problem, and one for which no practical method has yet been devised for use in the field.

The means whereby sterilization is effected are briefly:—

(*a*) Heat.

(*b*) Filtration.

(*c*) Chemical treatment.

(*d*) Electrical treatment.

The apparatus devised for employing these are very numerous For the sake of completeness, these will be mentioned, but only those which are approved will be described in detail.

Heat.

28. **Boiling.**—Simple boiling in kettles, degshais, cauldrons, etc., tends to deposit the greater part of suspended matter and effects complete sterilization. Water, thus treated, should be poured boiling into water-bottles and not allowed to remain uncovered to cool.

A practical difficulty is that of obtaining sufficient fuel, and unless strict supervision is exercised, railway sleepers and even stretchers will be broken up to provide firewood. Furthermore the expenditure of fuel is costly, the water, when boiled is flat and insipid, and is not ready for drinking until cooled.

29. **Heat Exchange Apparatus.**—Many varieties have been experimented with at one time or another by different armies. In all but the Griffith pattern, the water was actually boiled. In the Griffith, the water is raised to 80-90°C. and cooled automatically by the inflowing water, which is only separated from the outflowing sterile water by the thinnest of plates. The apparatus is cumbersome and not suited to Indian transport.

Filtration.

30. This term is elastic and ranges from simple clarification or removal of gross suspended matter and colour, to true filtration or the removal of bacteria and other minute forms of suspended matter.

Coarse filtration.

31. (*a*) Coarse straining can be effected by passing water through blankets, porous canvas, etc.

(*b*) A form of field apparatus used by the Japanese army is known as the Ishiji filter, and consists of an inverted canvas cone, flushable at the bottom and provided with lateral projecting arms of canvas fitted a short distance above the apex and plugged with a mixture of alum, charcoal, silicon and potassium permanganate. The water percolates through these chemicals in the arms and is clarified. (*See* fig. 1, Plate 1.)

(*c*) Maignen's 'Filtre Rapide.' This was a charcoal filter, now abandoned.

Fine filtration.

32. **(A) Candle filters.**—Examples of these are the Pasteur-Chamberland and the Nordtmeyer-Berkefeld. Many other makes exist, but only two main types are made.

One (*e.g.*, the Pasteur-Chamberland) uses a candle of prepared fine-grained unglazed porcelain: the other (*e.g.*, the Nordtmeyer-Berkefeld) a candle composed of a diatomaceous earth called *Kieselguhr*. The latter candle, though of the same external diameter, has a smaller bore and the walls are therefore much thicker. The candle is less smooth but more porous and brittle. Candles of the Pasteur type are the only ones to deliver a microbe-free water, and all other types are unreliable.[8] Among the many objections to candle filters the following are mentioned:—

(*a*) Cracks or flaws may exist without possibility of detection.

(*b*) Metal attachments and screws, if worn, allow unfiltered water to leak through.

(*c*) Fine sand or clay blocks the pores.

(*d*) The delivery is always slow.

(*e*) Constant washing and sterilization are necessary as organisms gradually grow through the candle interstices.

(*f*) They are so fragile that they break easily when transported over uneven roads.

(*g*) They crack instantly, if plunged into boiling water for sterilization purposes.

33. **(B) Sand filters.**—The types are now somewhat numerous:—

Bell's pressure, gravity, and mobile filters.

Jewell pressure and gravity filters.

Patterson's pressure and gravity filters.

Mather and Platt's pressure and gravity filters.

The Turn-over filter.

The Candy filter.

Reisert pressure filter (German).

Ransome VerMehr drifting sand filter.

United Water Softener Company's mobile filter.

Of the fixed installations, two may be briefly described, serving as types.

(1) *Jewell*.—(Plant installed at Bangalore.) The head of water in the pressure filter varies from 1-10 feet. The sand is 3 feet deep on a gravel bed supported on branching outlet pipes embedded in concrete. The outlet water passes through a 'water controller' which regulates the rate of outflow and also indicates the pressure on the filter so that the attendant knows when the filter requires washing. In cleansing, the inlet and outlet valves are closed and the wash-out valve opened. Filtered water is thus admitted from below and simultaneously the sand is raked by revolving arms, the motive power for which is supplied by a small oil engine. The time taken in washing is 4-5 minutes and the water used equals 2½-5 per cent. of the quantity that filters in the time between two washings. The coagulant used is sulphate of alumina which is dissolved in tanks to form a saturated solution.

In the gravity filter the head of pressure should not be greater than 10 feet. The output of a 360 square foot surface is about one million gallons per day.[9]

(2) *Patterson*.—(Plant installed at Poona, Deolali). This differs from the Jewell in no essential detail, but the cleansing process is carried out by means of compressed air which is made to agitate the bed for ½ minute. It is claimed that there is more uniform agitation of the sand and that less wash-water is used.

34. Mobile (Mechanical Transport) Filter Plants.—For certain types of warfare these are extremely valuable. Good transport roads are, however, required. There are three principal makes:—

Ransome VerMehr Drifting sand filter.

Bell's plant.

United Water Softener Company's plant.

The first two deliver from 400-500 gallons of water per hour and weigh when empty between 2½-3½ tons. Both use alum as a coagulant and bleaching powder as a chemical sterilizer. 10 cwt. of coarse-graded sand are used in both. De-chlorination is carried out in the Ransome VerMehr only, [illegible] treatment with lime or soda is used in Bell's apparatus.

The United Water Softener Company's plant delivers 1,200 gallons per hour and uses 16 cwt. of coarse-graded sand. Chlorination is effected by chlorine gas stored in cylinders, for which

the Ransome VerMehr is also adaptable. De-chlorination is effected by liquid SO_2, also stored in cylinders.

The distinctive characteristic of the Ransome VerMehr pressure filter is the employment of a bed of gradually-moving sand as the means of effecting the first or gross filtration. This moving sand removes the principal impurities before they come into contact with the fixed beds of sand and gravel which serve for the final filtration Owing to the angle on which the sand rests, the moving layer drifts almost imperceptibly, grain by grain, under its own weight to a washing chamber situated at the bottom of the filter and in this movement it forms a continuous series of surfaces or filtering films

The sand after having been completely and automatically washed free from impurities in this lower chamber which is outside the body of the filter, is continually replaced by means of the incoming non-filtered water and deposited afresh on the top of the moving sand layer Beneath the moving sand layer is a fixed bed composed of graded sand, or quartz and gravel. Uniform filtration normally proceeds for from 14-28 days, without it being necessary to cleanse the fixed bed [Plate 1, fig. 2.]

Chemical Treatment.

35. Chemical treatment, to be complete, aims at three objects —

(*a*) Sedimentation.

(*b*) Precipitation

(*c*) Sterilization.

Sedimentation.

36. This is effected in time by gravity. To a small extent the suspended particles, in falling, carry down with them some of the bacteria. As a factor in purification in any but large storage tanks, sedimentation plays a very small part.

Precipitation.

37. The coagulants commonly used are sulphate of aluminium alum, and occasionally sulphate of iron The term 'alum' covers potash, ammonia and soda alum. Aluminium sulphate in the crude state and containing iron, is also used and is known as Alumino-ferric.

Whichever salt of aluminium is used, the alkaline carbonates present in the water decompose the chemical with the formation of aluminium hydrate, which is thrown out of the solution as a flocculent, colloidal, jelly-like precipitate. The reaction is as follows :—

$$Al_2(SO_4)_3 + 3Ca(CO_3) = Al_2(CO_3)_3 + 3CaSO_4$$

$$Al_2(CO_3)_3 + 6H_2O = 2Al(OH)_3 + 3H_2O + 3CO_2$$

The calcium carbonate is necessary to break up the alum, and if not normally present in the water some lime or soda must be added. The precipitated aluminium hydrate clears the water very much as white of egg clears coffee. The amount of alum added to the water must vary from time to time, depending on the turbidity, the reaction and also upon the amount of calcium carbonate in the water [10] The turbidity and composition of many Indian streams vary suddenly and require a watchful eye.

Alum.—As a result of numerous experiments, it has been found that the best dose of alum for the perfect clarification of soft water is obtained by adding half the equivalent weight of alum necessary to react completely with the alkalinity calculated as calcium carbonate. For a hard water the same rule holds good.

A watery solution of logwood gives a reddish colour when the correct dose has been used, and a gradation of shades of purple or lavender if an excess is added.[11] The amount usually required varies from 5-15 grains per gallon.

38. Method of use.—The chemical used may either be dissolved previously and added in a liquid state, or be powdered and so added, or be tied in muslin and stirred through the water until dissolved.

Where single tanks are used for combined sedimentation and sterilization, sedimentation and precipitation are usually carried out first, but equally good results appear to be obtained by reversing this order, and there is the possible advantage that if the water is required urgently, sterilization has at least been effected.

Where a two tank system is in vogue—one for alum treatment and one for sterilization—arrangements should be made to siphon off only the supernatant water from the settling tank. In such cases alum treatment is always carried out first.

The longer the time given, the better are sedimentation and precipitation achieved, but in practice not more than half an hour is usually allowed, except in large water stations.

Sterilization.

39. **Chemical methods of purifying water.**—Various chemical means have been devised for field service use—

(*a*) Potassium permanganate.

(*b*) Sodium bisulphate tablets.

(*c*) Nesfield's Iodine tablets.

(*d*) Chlorine either as—

(i) Gas from cylinders.

(ii) Bleaching Powder.

(iii) Gas evolved from chemicals.

(iv) Solutions containing hypochlorites, chemically or electrolytically prepared.

(v) Organic chlorine compounds.

40. **Potassium permanganate.**—It has been claimed that ½ grain to a gallon will sterilize a water in 1 hour Such statements are misleading as, the process of sterilization being one of oxidation, the quantity of chemical required depends largely on the quantity of oxidizable organic matter present.

Potassium permanganate has fallen largely into disuse, as the colour imparted is objectionable, the action feeble and uncertain, and moreover the chemical is now difficult to obtain.

It has, however, a great lethal action for cholera vibrios, for which reason it is still used as a rough and ready method of sterilizing wells. To obtain the best effect, commence by adding one ounce of potassium permanganate for each 2,000 gallons, sprinkling the crystals over the water surface. Wait 20-30 minutes and then withdraw a bucketful, noting whether the pink colour remains. If not, add permanganate, ounce by ounce, until the colour is not discharged by the organic matter in the water.

The well should be left untouched for 24 hours.

41. **Sodium bisulphate.**—Tablets of this chemical, which depends for its action on the sulphuric acid contained, have been frequently

used on service. The dose is 15 grains to 1 pint of water. Another form of tablet is composed of 2 grammes of 70 per cent. bisulphate sweetened with saccharin and flavoured with oil of lemon. One tablet suffices for $1\frac{3}{4}$ pints or the contents of a soldier's water-bottle.[12]

The idea of these tablets, originally, was that each soldier should carry them and sterilize his own drinking water. In practice this fails, partly because of ignorance, partly through prejudice against the taste imparted to the water and partly because of the time the soldier must wait before the water may be drunk. The tendency therefore of present day campaigns is to centralize as far as possible water-sterilization operations.

The objections to this chemical, apart from those given above, are that it does not always sterilize water and the chemical rapidly deteriorates These tablets are, however, of value to units working in detachments too small to allow of a bulk-sterilizing apparatus being supplied, and in particular to cavalry men who may often operate far afield.

If aluminium water-bottles are used, the sulphates formed by the acid are non-toxic in the quantities drunk If iron bottles are provided, even if zinc-lined, a thick brown ferrous sulphate forms Marked action also occurs on alloys such as 'nickel silver,' 'German silver,' 'white metal' and 'Brittania metal' containing copper, and as much as $1\frac{1}{2}$ grains may be dissolved in 24 hours in a single bottle This poison is cumulative.

For the above reasons, cavalry men should be provided with aluminium water-bottles, and in metal pakhals and medical water-bottles the process should never be used. A simple test for copper is to add potassium ferrocyanide when a bronze colour is produced.[13]

42. Iodine Tablets.—Three tablets are required: the first and second for the preparation of iodine and the third for de-iodizing the water afterwards.

Tablet A consists of 15 grains of potassium iodide iodate.

Tablet B consists of 15 grains of citric acid.

Tablet C consists of 15 grains of hyposulphite of soda.

If A and B are crushed together in a receptacle containing the smallest quantity of water sufficient to dissolve them, free

iodine is liberated. This solution is sufficient for 50 gallons of water. The water is allowed to stand for 10 minutes after addition of the iodine, and then C is powdered and added. This discharges both the colour and the taste of iodine. The chemicals do not deteriorate. The method is a good one but requires careful supervision.

Chlorine.

43. Gas cylinders.—This method has not been tried practically for the Army in India. Gas cylinders are furthermore difficult to procure and require cold storage in hot weather.

44. Bleaching powder.—Bleaching powder as issued by the manufacturer is reckoned to contain 33 per cent. available chlorine. The chemical is, however, extremely unstable and great difficulties have been experienced in re-packing it so that deterioration is not excessive. Tins filled with this powder very quickly rot through. Glass jars are difficult to render air-tight at the stopper and have the further disadvantage of being fragile on service. Probably the best method yet devised is to line a receptacle with pitch which is unacted on, and seal the stopper with the same material.

Until experience shows that bleaching powder can be packed so that at the time of use it contains the quantity of chlorine stated on the label, it is essential to re-determine the percentage of available chlorine immediately before use; otherwise it will often happen that an inert chemical is being added to a water and sterilization is not effected.

The precise chemical action whereby bleaching powder becomes a disinfectant is not certain, but probably in air it acts by libertion of chlorine and in water by loss of all its oxygen. The sterilizing power is probably partly due to the toxic action of hypochlorite and partly to oxidation.[14]

45. To determine the Chlorine content.—(*A*) *Penot's method*—

(*a*) Dissolve 4·95 grammes of Arsenious acid (As_2O_3) in a litre of water, and add 25 grammes of pure sodium carbonate. Solution is effected on a water bath or by immersion of the flask in boiling water.

(*b*) Weigh out 10 grammes of bleaching powder and mix with water to form a thin cream; wash into a flask and fill up to 1 litre.

(*c*) Starch-Potassium iodide papers are required.

Place 10 c.c. of the bleaching powder solution in a flask and run in from a burette the arsenic solution drop by drop, until no blue colour is given to starch-potassium iodide paper when the latter is touched by a rod dipped in the mixture. Read off the number of c.c. of arsenite solution used. Each c.c represents 3·55 per cent. chlorine in the bleaching powder examined.

(*B*) *Thiosulphate method.*—This method is not so accurate, the error being however less than 1 per cent.

(*a*) Dissolve 10 grammes of bleaching powder and make up to 1 litre as before.

(*b*) Add 1 gramme of Potassium iodide and a little freshly-prepared boiled starch solution to the above, when a blue colour is given.

(*c*) Add 10 c.c. of the resulting mixture to 10 c.c. of dilute hydrochloric acid.

(*d*) Dissolve 24·8 grammes of Sodium thiosulphate (Hypo) in a litre of water and run in this solution to (c), drop by drop from a burette.

Each c.c. of the thiosulphate solution used represents 3·55 per cent. chlorine in the bleaching powder examined.

(*C*) *Morison's method of standardizing Bleaching powder solution.*—Reagents required are:—

(*a*) Standard Thiosulphate solution ($\frac{N}{71}$), made by dissolving 35·[illegible] grammes of clean dry crystals of Sodium thiosulphate in 1,000 c.c. of water, which has been previously boiled and sedimented. The hypo should be dissolved in about half the required quantity of water and then carefully made up to 1,000 c.c It must be standardized against standard $\frac{N}{71}$ Iodine solution supplied by a Laboratory. 5 c.c of Iodine solution should require 5 c.c. of hypo solution. Failing this, a factor may be found; *e.g.*, 5 c.c. Iodine solution required 4·2 c.c. hypo solution: the factor then is $\frac{5}{4{\cdot}2}$ =1·19. This factor and the date of testing the hypo solution should be clearly written on the label.

(*b*) Hydrochloric acid (50 per cent.). The strong acid supplied by Medical Stores should be diluted with an equal volume of boiled and sedimented water.

(*c*) Potassium iodide solution (10 per cent.). Dissolve 1 oz. of iodide of potassium crystals in 10 ozs. of boiled and sedimental water.

(*d*) Starch solution (1 in 80). Stir well ¼ oz. of starch powder with 2-3 ozs. of cold water. In a clean tin, boil enough water to make up to 1 pint when mixed with the starch solution, and when boiling add the starch mixture slowly, stirring continuously. Continue boiling gently for ten minutes. Then cool.

(*e*) Starch and Iodide Test solution. This is made up as follows:—

Starch solution (*d*) . . .	80 parts or 1 pint.
Potassium iodide solution (*c*) .	10 parts or 2½ ozs.
Water, boiled and sedimented .	10 parts or 2½ ozs.

Add ~~2-3~~ drops of chloroform as a preservative, and keep the bottle in a *cool dark place* when not in use.

Note.—For use with chlorinators during hot weather, this test solution should be freshly made every 2 days. Even when kept cool in a receptacle half-filled with water, this test solution soon loses its sensitiveness in hot weather. If not kept reasonably cool, it may become almost useless in a few hours.

Method of testing bleaching powder solution—

(*a*) Carefully rinse a pipette with clean water and then with a little of the bleach solution to be tested. Fill the pipette with bleach solution and very carefully run 5 c.c. into a *clean* wide-mouthed bottle or white-enamelled cup.

(*b*) Add a little clear settled water to the bleach solution in this bottle or cup. (An equal quantity will do and it need not be measured). Then measure into a *clean* test tube about 10 c.c. of iodide of potassium solution and 2 c.c. of hydrochloric acid solution, shaking gently to mix.

(*c*) Fill ~~another~~ burette with standard hypo solution, first rinsing with water and then some of the solution. Then fill to above the zero mark, open and close the glass tap quickly to expel all air from the portion of the burette below the tap, fix in a wooden stand and note carefully the level.

(*d*) Pour the mixed iodide and acid solution from the test tube into the bottle or cup and *at once* begin to drop hypo solution from the burette into the cup, until the dark brown colour has faded to a pale yellow. Close the burette tap and then add a *few drops* of starch and iodide test solution to the cup. A deep blue colour will be formed. Then continue adding hypo solution slowly, drop by drop, until this colour disappears The *last drop* should change the colour from fairly deep blue to colourless.

(*e*) Having added the exact amount of hypo solution needed to discharge the blue colour, read the level of the solution again in the burette. The difference in readings shows the amount used. Say this is 12·8 c c Then if the hypo solution is of exact standard strength, the strength of the bleaching powder solution is found by dividing the number of c.c. of hypo used by 10. In this example the solution contains 1·28 per cent Chlorine. If the hypo solution is not of exact strength and the factor be known, then to find the percentage chlorine, first multiply the number of c.c. of hypo solution used by the factor before dividing by 10.

As bleaching powder solution when prepared in bulk will usually be above the strength (1·28 per cent.) usually issued for water-sterilizing purposes, dilution is required. The quantity of water to add is found by dividing the percentage strength of the bulk solution by the percentage strength of the solution required and making up the bulk (whether gallons, ounces or litres) as follows :—*e.g.*, the bulk solution is found to be 3·2 per cent chlorine and a 1·28 per cent. solution is required. Divide 3·2 by 1·28 and 2·5 is given. Then 1 gallon of 3·2 per cent. solution must be made up to 2·5 gallons with water to give a resulting mixture of 1·28 per cent strength.

These processes will not ordinarily be carried out in the field except by units whose duty it becomes to standardize and issue bleaching powder in solution

46. It has already been pointed out in section 41 that the sterilization of water has passed more and more from the hands of the individual soldier to special officers or units employed for this purpose. This leads to the next consideration, *i e*, the issue of bleaching powder to units in the field. It has been found that the best

method of overcoming the difficulties which arise on account of the rapid deterioration of bleaching powder in damp and hot climates, is for a solution of the powder to be made as soon as it is necessary to break up a carefully-packed consignment for distribution in smaller quantities.

The special squad of the sanitary section will undertake these duties, and where this unit is not available, it will be found highly advantageous to establish as soon as possible some similar unit by selecting men from regimental sanitary detachments Arrangements should be made with the Supply and Transport, local messes and units for the conservation of all wine and other bottles, and their collection Corks and gummed labels also should be arranged for and for economy of time the latter should either be printed or a rubber stamp be procured for indicating the strength of the solutions as issued. The necessary chemicals and apparatus will be provided on special indent.

47. **Solution of Bleaching powder.**—Chlorinated lime is soluble in about twenty times its weight of water, yielding an insoluble precipitate consisting mostly of calcium hydroxide, $Ca(OH)_2$ Half a pound of bleaching powder may be dissolved in a gallon of water Such a solution contains approximately 6 per cent. by weight of chlorinated lime, representing about 2 per cent. available chlorine, if the bleach is of 33 per cent. strength.

To obtain a clear solution it is important to remember that the available chlorine is readily soluble, and the undissolved sludge of calcium hydroxide, silica, etc., settles quickly if a few simple rules are observed :—

(i) Do not mix too stiff a paste, otherwise a gelatinizing action takes place and greater difficulty in settling is encountered.

(ii) Never make a paste with less than half a gallon of water for one pound of bleaching powder.

(iii) It is not necessary or desirable to grind up or break up the lumps too thoroughly; the available chlorine nearly all dissolves readily, and too much agitation is detrimental to prompt settling[15]

An ordinary milk churn may be used to effect solution

48. **Amount of chlorine required.**—As a rough guide, in the absence of a specific direction by the Consultant Chemist or other authority, 1 part of Chlorine to 500,000 parts of water

is a safe standard to adopt in India to effect sterilization of field water supplies, even where the organic contamination is marked. It must be understood that sedimentation and precipitation influence the quantity of chlorine required. This will be realized when it is mentioned that the suspended organic matter in a water is attacked by the sterilizing agent with equal, if not greater, avidity than the bacterial organisms present. Thus, though a definite quantity of chlorine may be added, a large amount may be destroyed by other impurities and the quantity of chlorine available as a bactericide may be below the minimum necessary. Where a water has been thoroughly clarified, 1 part of Chlorine to 1,000,000 parts of water is frequently sufficient.

When the residual chlorine in a freshly-treated water exceeds 1·3 parts per million, the taste is distinctly perceptible but this taste gradually disappears.

A practical point to be remembered when treating water stored in tanks and similar receptacles, is that over-chlorination and an objectionable taste will result if the residual already-chlorinated water is not first run off or taken into account.

49. Test apparatus.—A portable field apparatus has been devised to enable a rapid and fairly accurate calculation to be made as to the quantity of chlorine required for each water.

The test apparatus consists of a box with two sides hinged below on which, when let down, the testing cups are placed. The contents of the box are as follows :—

A. (i) Six conical cups, enamelled *white* inside, to be filled within a quarter of an inch of the brim with the water to be tested.

(ii) One cup enamelled *black* inside to be used for making the chloride of lime solution.

B. Two tin spoons each holding 2 grammes when filled with bleaching powder level with the brim.

C. A test solution (zinc iodide and starch) in glass bottles, three drops of which give a definite blue colour with water containing one part per million of free chlorine.

D. Six pipettes, each of such a bore that one drop from the chloride of lime solution (ii) added to the water to be tested in the white enamelled cups filled as directed under A (i), gives a dilution of chlorine of one part per million.

E. Handkerchief. A handkerchief of thin material is provided. One fold of this placed over the finger covering the end of the pipette enables a novice to add uniform drops to the water.

F Stirrers. Four glass rods are provided for this purpose.

Method of Using Apparatus.

A. When water is not immediately required for use, it is best to clarify the water in the evening—

(i) Fill the cup enamelled *black* up to the mark on the inside with clarified water, then add one level spoonful of bleaching powder, and mix thoroughly. Place the cup on the top of the box.

(ii) Place the cups enamelled *white* in the holes on the two sides of the box. Fill each cup with clarified water to within a quarter of an inch of the top.

(iii) By means of a pipette, held vertically, add to each of the cups 1, 2, 3, 4, 5 and 6 drops respectively of the bleaching powder made as directed in (i). Mix thoroughly.

(iv) To each of the cups then add three drops of the test solution contained in the glass bottle. Stir vigorously and allow to stand for half an hour.

(v) Some of the six cups will usually show a blue colour at the end of that time. Then add to the water one measure of the bleaching powder, made into a paste with clarified water, for every drop of the solution from the black enamelled cup, contained in the *weakest* strength which has maintained a blue colour for 30 minutes. Say that the blue colour has disappeared from the cups containing 1, 2 and 3 drops, but was maintained in the cup containing 4 drops, then 4 measures of bleaching powder should be made into a paste with clarified water placed in the black enamelled cup, previously emptied and washed out, and added to the water and the water thoroughly stirred with a stick previously washed with clarified water.

(vi) Allow the chlorinated water to remain until the following morning. The water will then be quite free from germs causing water-borne disease

Note.—If the blue colour disappears in half an hour from all the cups the test must be made again, adding to the water in

the cups 7, 8, 9, 10, 11 and 12 drops respectively of the solution made as described under (1)

50. Table of amounts of Bleaching powder required.—The following table has been drawn up to show at a glance the quantities of bleaching powder of different chlorine content required for varying quantities of water, to give 1 part of Chlorine in 500,000 parts of water.

The amount in grains for 1 gallon $= \frac{14}{x}$; where x = percentage Chlorine.

TABLE.

Gallons.	1	100		250			500			750			1000.			2000.		
CHLORINE.	APOTHECARIES' WEIGHT																	
Per cent.—	Grs	Dr.	grs	Oz.	dr.	grs	Oz	dr.	grs	Oz.	dr	grs	Oz	dr.	grs	Oz	dr	grs
33	·424	0	42·42	0	1	46 0	0	3	32	0	5	18	0	7	4	1	6	8
32	·437	0	43·75	0	1	49 4	0	3	39	0	5	28	0	7	18	1	6	35
31	·451	0	45·16	0	1	52 9	0	3	46	0	5	39	0	7	32	1	7	3
30	·466	0	46 66	0	1	56 7	0	3	53	0	5	50	0	7	47	1	7	33
29	·482	0	48·27	0	2	0 7	0	4	1	0	6	2	1	0	3	2	0	5
28	·500	0	50 00	0	2	5 0	0	4	10	0	6	15	1	0	20	2	0	40
27	·518	0	51 85	0	2	9 6	0	4	19	0	6	29	1	0	39	2	1	17
26	·538	0	53·84	0	2	14 6	0	4	29	0	6	44	1	0	58	2	1	57
25	·560	0	56 00	0	2	20 0	0	4	40	0	7	0	1	1	20	2	2	40
24	·583	0	58 33	0	2	25·8	0	4	52	0	7	18	1	1	43	2	3	27
23	·608	1	0 87	0	2	32·2	0	5	4	0	7	36	1	2	9	2	4	17
22	636	1	3 63	0	2	39 1	0	5	18	0	7	57	1	2	36	2	5	13
21	666	1	6·66	0	2	46 6	0	5	33	1	0	20	1	3	7	2	6	13
20	·700	1	10 00	0	2	55 0	0	5	50	1	0	45	1	3	40	2	7	20
19	·736	1	13 68	0	3	4 2	0	6	8	1	1	12	1	4	17	3	0	31
18	777	1	17 77	0	3	14 4	0	6	29	1	1	43	1	4	58	3	1	55

TABLE—*contd.*

Gallons.	1.	100.	250.	500.	750.	1000.	2000.
CHLORINE							
17	·823	1 22·35	0 3 25 9	0 6 52	1 2 18	1 5 44	3 3 27
16	·875	1 27·50	0 3 38 8	0 7 18	1 2 57	1 6 35	3 5 10
15*	·933	1 33·33	0 3 53 3	0 7 47	1 3 40	1 7 33	3 7 7
14	1 000	1 40 00	0 4 10 0	1 0 20	1 4 30	2 0 40	4 1 20
13	1 076	1 47·69	0 4 29 2	1 0 58	1 5 27	2 1 57	4 3 54
12	1 166	1 56 66	0 4 51·7	1 1 43	1 6 35	2 3 27	4 6 53
11	1·272	2 7 27	0 5 18 2	1 2 36	1 7 54	2 5 13	5 2 25
10	1 400	2 20 00	0 5 50 0	1 3 40	2 1 30	2 7 20	5 6 40
9	1·555	2 35 55	0 6 28·9	1 4 58	2 3 27	3 1 56	6 2 12
8	1 750	2 55 00	0 7 17 5	1 6 35	2 5 53	3 5 10	7 2 20
7	2 000	3 20·00	1 0 20 0	2 0 40	3 1 0	4 1 20	8 2 40
6	2 333	3 53 33	1 1 43 3	2 3 27	3 5 10	4 6 53	9 5 46
5	2·800	4 40 00	1 3 40 0	2 7 20	4 3 0	5 6 40	11 5 20

* The standard of bleaching powder to be aimed at for stock supplies is 25 per cent. and over, preferably 33 per cent Chlorine

Bleaching powder below 15 per cent Cl should not be issued for unit chlorination, or employed in making standard solutions for the same Bleaching powder below 15 per cent and above 5 per cent Chlorine may be used in automatic chlorinators Below 5 per cent it should be scrapped for [illegible] may be used as a general deodorizer in latrines, etc For the [illegible] good bleach of 15 per cent. and over is required

Where bleaching powder is issued in solution and the percentage of available chlorine is stated, the following table shows the quantity in fluid measure necessary to add to varying quantities of water to give 1 part of Chlorine in 500,000 parts of water. 1 minim in 1 gallon = 1 part per 76,800.

The quantity in minims for 1 gallon $= \frac{15\ 36}{x}$, where x = the percentage Chlorine.

TABLE.

Per cent Cl in solution.	GALLONS																			
	1	100			250			500			750			1000			2000			
	Mins.	Oz	dr.	m	Oz	dr	m.	Oz	dr.	m	Oz	dr.	m	Oz	dr	m.	Oz	dr	m	
7·68	2	0	3	20	1	0	20	2	0	40	3	1	0	4	1	20	8	2	40	
5·12	3	0	5	0	1	4	30	3	1	0	4	5	30	6	2	0	12	4	0	
3·84	4	0	6	40	2	0	40	4	1	20	6	2	0	8	2	40	16	5	20	
2·56	6	1	2	0	3	1	0	6	2	0	9	3	0	12	4	0	25	0	0	
1·92	8	1	5	20	4	1	20	8	2	40	12	4	0	16	5	20	33	2	40	
1·536	10	2	0	40	5	1	40	10	3	20	15	5	0	20	6	40	41	5	20	
1·28	12	2	4	0	6	2	0	12	4	0	18	6	0	25	0	0	50	0	0	
·96	16	3	2	40	8	2	40	16	5	20	25	0	0	33	2	40	66	5	20	
·64	24	5	0	0	12	4	0	25	0	0	37	4	0	50	0	0	100	0	0	
·32	48	10	0	0	25	0	0	50	0	0	75	0	0	100	0	0	200	0	0	

The above table is based on the assumption that Sanitary Sections will issue bleaching powder solution in one of the percentages mentioned, usually 1·28 per cent. Dosage is simplified, as each percentage given is wholly divisible into 15·36, the factor given above.

51. For large water installations automatic chlorinators are frequently used. Two are mentioned.

(*a*) *Cree-Brown Apparatus.*—This consists of a receiving tank, the hypochlorite solution being mixed with the water to be treated as it leaves this tank The mixing apparatus consists of a glass gauge protected by a brass tube partly cut away, which stands beside the receiving tank and is connected to a three-way cock. When this cock is turned on, the hypochlorite solution from the gauge-glass and the water from the receiving tank simultaneously run from the pipe into a lower tank. The correct proportions result from the levels in the gauge glass and receiving tank falling at the same rate. The sides of the receiving tank must be vertical.[16]

(*b*) *Neddle-valve Suction Chlorinator.*—This is used in connexion with piped water supplies. The apparatus consists of an upper metal chamber containing a standardised solution of bleaching powder, from which a pipe leads downwards to a needle valve. The valve is adjusted by means of a screw furnished with a brass disc graduated into 32 large divisions with each division again sub-divided. The needle valve is composed of hard bronze (*e g.*, Copper 90 per cent. ; Tin 9 per cent ; Zinc 1 per cent) and is provided with a 20-thread worm to the inch. The solution on passing through the needle valve is piped to the water main and is aspirated by the flow of water in the latter. Piping is of copper and junctions are effected by means of bronze plug stop-cocks.

Gas evolved from chemicals.

52. Chlorine evolved from Potassium chlorate.—The other chemical used is strong hydrochloric acid. The process became used in India owing to the difficulties presented through the deterioration of bleaching powder Various kinds of apparatus have been devised, the most perfect one (*i.e* , Nelson's) being designed to consist largely of vulcanite

Beyt's Apparatus.—This apparatus is issued by Medical Stores and consists of the necessary glass bottles, tubing, rubber corks, etc , with spares, packed in a Venesta wood box, the total weight of which is roughly 11 pounds. The directions for use are as follows :—

(*a*) Put 20 ozs of water in one of the 2 lb. bottles.

(*b*) Connect the glass tube of the indiarubber cork with one hole, with the bent glass tube of the indiarubber cork with two holes.

(*c*) Cork the bottle of water with the cork having two holes.

(*d*) Crush three 5 grain tablets of Potassium chlorate and place the powder in the small bottle.

(*e*) Measure 2 drams of strong hydrochloric acid and put into the small bottle containing the powdered chlorate of potassium Cork the bottle with the one-holed cork as soon as chlorine begins to be evolved.

(*f*) From time to time open the clip to lower the pressure in the large bottle. If it is desired to hasten the evolution of chlorine, stand the small bottle in a vessel containing boiling water.

(*g*) When the small bottle contains no trace of powder or crystals, the process is complete. The indiarubber cork with the tubes should now be removed from the large bottle containing the chlorine solution. This bottle should then be corked with the glass stopper which belongs to it. Each large bottle bears a number corresponding to that on its own stopper.

(*h*) Use of the Chlorine solution for chlorinating water:—Preliminary sedimentation with alum is advisable. One ounce of chlorine solution by measure is sufficient to sterilize 5 gallons of water. After the addition of the chlorine solution, the water should be allowed to stand for about half an hour before being used.

53. Nesfield's Apparatus.—This bottle is included now in the Beyt's apparatus. Nesfield's method of evolving chlorine from the same chemical is extremely simple. The apparatus consists solely of a small glass-stoppered bottle of 1-2 ounce capacity. In the neck of the bottle 5 vertical grooves are cut with a file. The three 5-grain tablets are crushed and put into the bottle. One dram of strong hydrochloric acid is added and the stopper replaced at once. By means of a small piece of string attached to the neck, the bottle is lowered into either 20 ozs. of water (if a standard strength solution is required whereby 1 ounce will sterilize 5 gallons), or directly into a 100 gallon tank.

The gas, as it evolves, bubbles out through the grooves in the neck of the bottle and is absorbed by the water in which the bottle is lowered Two practical points may be mentioned. Firstly, some bottles do not sink and may require weighting with broken glass; secondly, the gas is sometimes evolved rapidly and some is lost before the stopper is replaced. This may be prevented by wrapping the potassium chlorate powder in a cigarette paper The stopper rarely blows out but should this happen, the remedy is simply to tie the two string tapes over the stopper or fit the bottle with a rubber band.

54. Chlorine evolved from Manganese dioxide.—Chlorine may also be evolved by the action of hydrochloric acid on Manganese dioxide

or the crude ore, or again by sulphuric acid on manganese dioxide and salt mixed. Both processes require apparatus and are therefore not suitable outside a laboratory.

55. **Summary of these methods.**—Objections to these methods of producing chlorine are many. Only limited quantities of chlorine solution can be made and more or less expert attention is required throughout the process of manufacture.

The apparatus, as issued now, is bulky and fragile. Rubber tubing quickly rots under the influence of the wet gas evolved. The rubber corks become hard, and then fit imperfectly, allowing leakage This leakage is accentuated by the head of pressure to be overcome by the gas.

Other objections are that hydrochloric acid is difficult to stopper and transport; potassium chlorate in bulk, as ship or rail stores, is potentially explosive, and, finally, the gas as evolved contains not only chlorine but euchlorine (ClO_2) and a somewhat objectionable taste is imparted to the water in consequence.

With the improvement in bleaching powder supplies and the possibility of manufacture therefrom of stable solutions, this method may be looked upon as only a temporary measure.

56. **Application of method to large tanks.**—Place the required amount of Potassium chlorate in a large empty bottle and add the required amount of Hydrochloric acid through a funnel. To find the amounts required, divide the capacity of the tank in gallons by 8 and it the resultant is multiplied by 1 it gives potassium chlorate in grains, and by 8, hydrochloric acid in minims. The chlorine given off and passed into the tank gives a strength of 1 in 500,000

Close the stopcock leading from the funnel and open the stopcock leading to the tank When all the potassium chlorate has been decomposed, which is indicated by gas ceasing to come off, fill the bottle with water through the funnel. In doing this, all contained gas is either displaced and passes into the tank or else goes into solution. When the bottle is full of water, open and pour the chlorine solution into the tank. No chlorine is then lost.

Hypochlorite solutions

57. **Chemically prepared.**—The solution of bleaching powder already referred to is a hypochlorite solution. Such a solution however

is not stable for long periods of time and furthermore requires standardizing at each manufacture. The production of a stable solution of constant high chlorine content and suitable means of packing the same, should go far to remove all difficulties in the way of sterilizing water supplies on field service.

58. **Electrolytically prepared.**—Hypochlorite solutions are readily prepared by electrolyzing a solution of common salt at low temperatures. The strength of such solutions is low, rarely exceeding 1·2 per cent. For this reason and its non-stability, electrolytic hypochlorite solution has not often been used practically for sterilizing water supplies. Such solutions are, however, useful as disinfectants. The same solution can be made from sea-water. The best known of plants is Mather and Platt's.

Organic Chlorine Compounds.

59. **Chloramine-T.**—This chemical is prepared from a by-product of saccharin. Its full name is paratoluene-sodium-sulphochloramide and in solid form may be preserved indefinitely. It is non-corrosive and non-toxic. A 15 per cent. solution can be formed from it and the compound contains 25 per cent. available chlorine. Its action on water is favoured by the presence of carbon dioxide, but much interfered with by the presence of magnesium salts. No taste is imparted to water but its action is slower than that of bleaching powder.[17]

60. **Halazone.**—Another aromatic chlorine compound of moderate stability is Halazone or *p*-sulphondichloraminobenzoic acid. It is put up in tablets and one tablet will sterilize one quart of water ; its use is limited to small quantities of water. These tablets are probably not so satisfactory as bi-sulphate of soda tablets as the chemical deteriorates rapidly in tropical climates.

Electrical Treatment.

61. **Ultra-violet Rays.**—These generated in vacuo by electrolyzed mercury vapour at incandescent heat, were at one time experimented with, but the action of the rays being interfered with by suspended matter in the water and such contaminated waters being those essentially met with on field service, the idea has been abandoned except as fixed installations in towns, etc. where a very clear water supply is obtainable unfiltered.[18]

Similar objections make the use of **Ozone** unsuitable.

Tests for Sterility.

62. **Starch-Iodide Test.**—To prepare starch-iodide solution, dissolve ½ oz. of Potassium iodide in 1 pint of water. Add this to mucilage of starch prepared by boiling ½ oz. of starch in ½ pint of water and made up to 1 pint with cold water.

Added to a water containing chlorine a blue colour is given. If a treated water contains a trace of chlorine at the end of half an hour, sterility (for pathogenic organisms) may safely be assumed.*

63. **Benzidine Test.**—Add 1 c.c. of a 0·1 per cent. solution of benzidine in 10 per cent. hydrochloric acid, to 100 c.c. of the water to be tested. A deep blue colour is given if chlorine is in excess, an orange colour as the excess disappears and finally a bright yellow colour when 1 part chlorine is present in 500,000 parts water. This test will indicate 0·005 parts chlorine per 1,000,000 parts water.[19]

64. **Bacteriological Test.**—One only will generally be necessary under field service conditions, *i.e.*, examination for presence of B. coli group. The standard to be aimed at *after chlorination* is absence of B. coli in 50 c.c.

Before chlorination, the ordinary empirical standards,[20] *i.e.*, not more than 1 bacillus coli in 10 c.c. river or stream water and total bacteria not over 100 per c.c., will prove very exacting in India where cattle pollute water supplies so freely. It must further be emphasized that to make a correct interpretation of bacteriological analyses requires considerable experience of practical conditions as well as of laboratory technique. Briefly waters may be divided into filtered and unfiltered. In filtered waters, amongst which may be included water from deep springs, bacillus coli should be absent in 100 c.c. For unfiltered waters, no standard is generally applicable.

Water Storage.

65. As the patterns and scales of water utensils are likely to be modified and will vary with transport conditions, the medical officer should ascertain on mobilization what the authorized equipment of his unit will be. For this reason the receptacles mentioned below are described only in brief and scales have been omitted.

(*a*) *Water-bottle.*—Capacity 1¾ pints Whilst usually manufactured of aluminium, it may in times of metal scarcity be made of zinc or galvanized iron. (See section 41.)

(*b*) *Chagul.*—Two patterns exist (1) Ambulance chagul with capacity of 1 gallon, and (2) a 2-gallon chagul

(*c*) *Pakhal.*—A zinc receptacle of 8 gallon capacity, covered outside with blanket cloth and rope netting. The blanket cloth is provided to allow of wetting, and so the cooling of the contents by evaporation

(*d*) *Tanks.*—The most serviceable unit tank is one made of canvas and for convenience in chlorination should be of 100-gallon capacity. [Plate 2.] Large metal or ferro-concrete tanks may be erected at railheads, or where transport allows. Mobile tanks, such as water carts and mechanical transport filters, have not been tried yet under Indian field service conditions.

66. Improvised receptacles, etc.—[Plate 3.] Local receptacles, such as Chatties, Persian hubs, "Diggies," etc., are often valuable adjuncts to the authorized equipment. In the choice of these, discard vessels which have narrow openings and do not permit of hand-cleansing. Before use, they should always be sterilized with boiling water or chemicals. When in use, dippers should be provided to prevent fouling by the insertion of individual *lotas*, etc.

Where paulins are used, they must have dust covers. The usual practice of digging out a place for a tank should be given up and mud walls be built up when possible Such tanks should be narrow and deep.

Where bitumen is available, serviceable tanks can be constructed with bricks and lined with this material.

67. Lyster Water Sterilizing Bag.—The following appliance designed by Major W. J. Lyster, U. S. Army Medical Corps, is described in detail as, with a little ingenuity, it can be improvised It consists of a canvas bag of woven flax, 20 inches in diameter and 28 inches in length, sewn to a flat galvanized ring, hinged so that it folds at one diameter. Spliced at four equidistant points on the ring are two crossed pieces of hemp rope enabling the bag to be suspended. The weight when filled with water is about 330 pounds. Five nickel spring faucets are

placed at equal spaces about the bottom edge of the bag. The neck of these faucets is small enough to enter a water-bottle which can be filled in 10 seconds. The empty bag weighs from 7-7½ lbs. and folds into a convenient package for carriage in the field. A filter cloth of muslin or flannel may be fastened over the inlet of the bag. After the bag is suspended and filled with water, the contents are sterilized by addition of bleaching powder etc[21] (This is really an improvement on the Ishiji Filter; see Section 31(*b*)).

Methods of cleansing receptacles.

68. (*a*) *Water-bottles, pakhals, etc.*—Put into the receptacle a weak pale solution of Potassium permanganate of strength 1 oz. to 2,000 gallons, shake thoroughly against the sides, leave for 5 minutes and then pour out. If the colour remains, the vessel is clean. If the colour disappears, repeat until clean. Iodine solution, 1 in 1,000, may also be employed.

(*b*) "*Diggies*" *and Tarpaulins* should be scrubbed once a week and left to dry in the sun.

(*c*) Large metal tanks require supporting on plints in such a manner that one side projects at least 9 inches to allow, if not already fitted, of a flush-out tap being provided at the bottom. A manhole is necessary at the top to allow of entry and thorough periodical scraping. Ordinary sediment is removed by flushing out, the stop-cock at the bottom being opened. The drinking water outlet pipe should be at least 6 inches from the bottom so that sediment is not drawn off.

N B.—Canvas water receptacles rot quickly when waters are very saline (*e g*, in Persia); such waters appear to predispose to the growth of *Aspergillus niger*, a fungus which has a peculiarly harmful effect on tents and canvas. Washing in strongly-chlorinated water has been suggested as a preventive of fungus growth.

Regulations regarding water supplies.

69. Receptacles.—Vessels or tanks in which drinking water is stored, as well as being carefully covered, should be raised off the ground and provided with taps Frequent cleansing and periodical disinfection are essential[22] Water tanks and water-bottles must be frequently inspected by a medical officer.[22]

(*N.B.*—Commanding officers also should satisfy themselves that the water arrangements are good.)

70. In camp.—As water-borne diseases are so frequently spread by contamination of water supplies by the troops themselves, protection of the source requires very constant attention. Whenever there is reason to suppose that a water supply may be contaminated, all water used for drinking or in kitchens will be boiled under regimental arrangements, or subjected to such other method of purification as may be available.[23]

Military Police, or in their absence the first troops to arrive, will mount sentries on all water supplies likely to be required for use, with such orders as will prevent any form of pollution. These sentries will not be withdrawn until permanent water guards are detailed.[24]

The water supply will always be selected in conjunction with the sanitary or other medical officer who will satisfy himself as to its fitness for use.[25] The medical officer (D. A. D. M. S. when available) will also advise on the methods of protecting the source, collecting, storing, distributing and purifying the water [26] (In this connexion, to prevent contamination of purified supplies by each soldier, special tin dippers must be provided for filling chaguls and water-bottles etc. A camp policeman should be on duty at all times to see that no drinking cups or water-bottles are dipped into storage tanks. Chlorinating stations should be established within easy reach of most units. Outlying units, unprovided for, should report at once to the nearest sanitary section or water unit so that special arrangements may be made).

If water is obtained from a stream, horses will be watered below the place where troops obtain their drinking water, but above bathing and washing places. Patrolling by mounted men will often be necessary above the spot where the drinking water is drawn.[27]

The water supply will usually be marked with flags by the advance party of engineers :—

White for drinking water,

Blue for watering places for animals,

Red for washing and bathing places.[28]

When necessary, notices will be put up showing the uses to which any supply is to be put, or sentries posted to ensure that instructions regarding it are carried out.[29]

[*N.B.*—Notices should be in the various languages necessary.]

A plan of the camp should be on view at the Commandant's office.[30]

If running water is not available, a rough barbed wire fence or some other form of fencing should be placed round the water supply to keep out animals which should in this case be watered by bucket or nosebag. Washing should be allowed only at some distance from the water supply. Similar precautions are necessary with running water if other bodies of troops are halted lower down the stream [31]

Whatever the source of water supply, if many animals have to be watered and the frontage is small, hours for watering and the route to and from watering places will be laid down for each unit. Three to five minutes may be taken as the average time for watering an animal.[32]

When ground is allotted, each commander must be informed of any localities or depôts outside his own area on which he may draw for water, etc.[33]

71. **On the march.**—If a long halt is contemplated, a staff officer accompanied by an engineer and a medical officer with sufficient police and orderlies should be sent forward to select halting grounds near good water. He should arrange for the methodical distribution of the water supply and take measures for its protection until the main body arrives.[34]

In movements by rail, troops are not to use the water supply without authority from a railway transport officer.[35]

72. **In Fortresses.**—Should the source of the water supply be without the area of the fortress, special arrangements for storage of water must be made.[36]

REFERENCES.

[1] Lelean ; Sanitation in War, page 288.

[2] Lelean , Sanitation in War, page 287.

[3] Military Works Handbook, India. 1901.

[4] F. S. R. I, 57(7).

[5] Lelean, Sanitation in War, page 286.

[6] F. S. Pocket Book, Chap II, Sect 11(1).

[7] F. S. Pocket Book, Chap. II, Sect 11(2)

[8] Reid; Practical Sanitation, Chap. II.

[9] Don and Chisholm; Modern methods of water purification, page 168 *et seq.*

[10] Rosenau; Preventive Medicine and Hygiene, page 891.

[11] Morison, Tropical Diseases Bulletin, Vol. X, page 18.

[12] Notter and Firth; Theory and Practice of Hygiene page 931.

[13] Lelean; Sanitation in War, page 311

[14] Lelean; Sanitation in War, page 315

[15] Rosenau, Preventive Medicine and Hygiene, page 902.

[16] Cree Brown; Indian Journal Medical Research, Vol III, page 614.

[17] Mackenzie Wallis; Ind. Journal Med. Research, Vol. IV, page 800.

[18] Lelean; Sanitation in War, page 305

[19] Mackenzie Wallis; Ind. Journal Med Research Vol IV, page 797.

[20] Rosenau; Preventive Medicine and Hygiene, page 868.

[21] Trop. Dis Bul 15th July 1917, page 19 Rosenau Prev. Med. and Hyg. page 1283

[22] F S. R, I, 46(4); F S Pocket Book, Chap II, 11(8)

[23] Medical Manual (War) India, 29(4).

[24] F. S. R., I, 57(1). F. S. Pocket Book, Chap. II, 11(10).

[25] F. S. R, I, 57(2).

[26] Medical Manual (War) India, 29(3).

[27] F. S. R., I. 57(3); F. S. Pocket Book. Chap II, 11(12)

[28] F. S. R., I, 57(4); F. S. Pocket Book, Chap. II, 11(11).

[29] Medical Manual (War) India, 29(3).

[30] F. S. R., I, 63(5).

[31] F. S. R., I, 57(5); F. S. Pocket Book, Chap. II, 11(13).

[32] F. S. R., I, 57(6).

[33] F. S. R., I, 57(4); F. S Pocket Book, Chap. II, 8(15).

[34] F. S. R., I, 31(4); Medical Manual (War), India, 29(2).

[35] F. S R., I, 34(6).

[36] F. S. R., I, 126(2V).

*CHAPTER III.

DISPOSAL OF WASTE PRODUCTS.

73. The subject of this chapter is the most important one in Field Sanitation. In this and other chapters it will be noted that the subject has not been confined entirely to field service conditions: this is done for two reasons; firstly, because the Lines of Communication in India are sufficiently long to bring one back to what may be called cantonment life, and secondly, because the principles of conservancy and the apparatus do not differ materially in the field, and many a more permanent device can with ingenuity be copied in the field in simpler form, if the principle is once explained.

74. Objects in disposal.—In the disposal of waste products the object to be aimed at is to render them innocuous. Innocuous is held to mean :—

(i) that pathogenic germs are eliminated and hence sources of infection are reduced,

(ii) that its nature is so changed that it no longer allows of the breeding of insects, flies, mosquitoes and other disease-carrying or obnoxious pests, and

(iii) that it causes no offence by vapours, smells, etc., either before or during the process of disposal.

75. Composition of waste matter.—Waste matter divides at once into solids and liquids, and these comprise :—

Solids—

Human faeces

Kitchen garbage.

Stable refuse.

General Camp Refuse :—

bits of crockery, tins, paper, rags, condemned bhoosa, stores, etc.

Carcases and Corpses.

Offal from slaughtering places.

Liquids—

Urine, human and animal.

Kitchen sullage (grease).

Ablution sullage (soap).

DISPOSAL OF SOLIDS.

Surface disposal.

76. The main objection to the surface disposal of any form of solid refuse is that the organic matter rapidly undergoes decomposition and so provides an ideal pabulum in which flies and insects of many varieties deposit their eggs and ultimately hatch in innumerable quantities. In addition the sight and smell are often peculiarly offensive.

At the same time there are occasions when this method must compulsorily be resorted to; *e.g.*, in the disposal of the carcases of several animals where burial or incineration is quite impracticable. Again, preparatory to incineration, it must often be adopted in order to dry litter of all kinds, but in such cases the ultimate disposal cannot long be delayed.

In the case of human excreta, were it not that privacy is naturally sought and hence selected sites are over-fouled, it is probable that less nuisance would be caused by the deposition of human excreta on the surface soil in parts of India where the sun's heat is extreme, the soil sandy and the population scarce, than is frequently caused by ill-supervised and primitive trenching. In practice no sanitarian would advocate this, except possibly in the single instance where a small body of troops is traversing a desert by a route unfrequented and not to be followed within a reasonable period by other troops or be re-traversed.

Manure.

77. As manure is rarely buried, the subject may best be dealt with here.

Litter and dung from lines, prior to removal and ultimate disposal by the methods about to be described, must be piled on an impervious platform provided with a raised edge on three sides. This should be swept clean daily.

78. **Drying platform for Manure.**[1]—(Plate 4, Fig. 1.) Suitable dimensions are:—10 feet square; walls 6 inches high; floor 4 inches thick and sloping towards the front edge to allow moisture to drain away.

It can be made of a mixture of 1 part sand to 7 of chopped straw ("tibbin"), mixed with the minimum of water to give plasticity. Addition of 1 part of cement gives a hard smooth surface. It should be allowed to dry in the sun for 24 hours, and drying then completed by burning litter on the surface. The less water used in mixing, the less likelihood will there be of cracks forming, which would require to be filled in with more plaster. Finally, the whole surface should be treated freely with crude mineral oil.

Litter should be spread so as to leave a clear margin of 1 foot width at the edges, and the whole surface should be swept clean every day. This platform is most useful in hot dry climates, and especially for horse manure which has to be burnt.

Methods of Disposal.

79. **Spreading.**—On hard level ground freely exposed to sun and wind, each day's litter and manure should be spread out in a thin uniform layer not exceeding one inch in depth, and well raked over in the afternoon of the same day and on the two following days, in order to break up the nodules of dung.

Owing to rapid dessication, manure thus treated soon ceases to be attractive to flies, and the heat of the sun kills eggs and larvæ exposed to it in a very short time. One day's manure from 500 horses standing continually in the lines, when spread as described, covers an area 25 yards by 25 yards. Three areas of the required size, separated by roadways 12 feet in width, should be marked out on a suitable spot (which need only be a few hundred yards from the lines), and used in succession for three days; after which, the first day's manure should be completely dry and then the fourth day's output may be spread as before on the top of the first, the fifth on the top of the second, and so on until the blocks of dry manure become inconveniently high, when fresh areas should be selected.

80. **Used for road-making.**—(Plate 4, Fig. 2.) Dry manure forms excellent roadways over desert sand. It was found possible in Egypt to utilize this substance in a manner to which no objection

could be taken on sanitary grounds Furthermore to find a use for a troublesome waste product is always satisfactory and it is particularly in sandy districts that manure is so difficult to dispose of by incineration owing to the admixture of sand. Tracks are excavated to a depth of 14-18 inches and filled with 10-12 inches of manure, dried or fresh This should be rolled if possible. On this, sand—or murram or budgery which bind better—is laid, watered, and rolled or rammed. When it wears thin, more sand, etc., should be added. Success depends upon the climate being dry and the foundation being porous, *e.g.*, sand or gravel, otherwise fermentation will set up rapidly and the road surface be forced up.[2]

81. **Close-packing.**—The success of this method depends upon the fact that the heat generated by fermentation in a closely-packed heap of fresh stable manure is as great as from 136-169 °F. four inches beneath the surface, whilst the house fly larvæ are rapidly killed at any temperatures above 114·8 °F.

Hard level ground should be prepared by puddling and smoothing the surface and allowing it to dry in the sun. The manure may either be dumped separately each day or the original dump be extended laterally. In either event the prepared surface of ground should extend three or four feet beyond the base of the heap.

The manure should be made into a compact rectangular block not exceeding five feet in height, with slightly sloping sides. Each load as delivered is beaten down with shovels and sprinkled with water in dry weather. Beating and smoothing the sides with shovels completes the process.

82. **Roubaud's method.**[3]—Roubaud claims that, from the sixth day, manure placed in heaps no longer contains larvæ, as these have migrated to the base for pupation. Anti-fly measures must, therefore, be undertaken within five days of stacking. For the first 24 hours fresh manure stacked in heaps does not contain larvæ but eggs. These then hatch and the larvæ migrate to the surface, leaving the hotter internal region where fermentation is greatest. He advocates, therefore, turning the surface layers each day on the 2nd, 3rd and 4th days after stacking, so that the larvæ are brought into contact with the heat of the interior and are therefore killed at once. If fresh manure is added daily to the stack, this should be buried in the hot parts and not merely laid on the surface.

Experiments conducted at Quetta on this method may be quoted.[4]

For the first six or seven days that this method was in operation it was only occasionally, and after careful search, that larvæ were found. The procedure then followed was to turn over the manure heap twice daily. The heap was made horseshoe shaped, the morning and evening collections were deposited in the concavity, covered over with the old manure to a depth of 18 inches, left for some 8 to 10 hours, and then the whole mass stirred up. At about the end of the first week the mass became very bulky. As the bulk increased it became more and more difficult to handle, with any certainty that the covering and mixing were properly carried out, and larvæ began to appear in large numbers. About this time there was a certain amount of rain which may have accounted for the increased breeding.

Instructions were now given that the fresh manure should first be deposited adjacent to the "heap." Later, after digging out the centre of the old pile the fresh manure was to be shovelled into the excavation and covered over. This was unsatisfactory as a portion of the fresh pile was always left *in situ*, and provided a suitable breeding place for the flies.

The next plan was to deposit the fresh manure adjacent to the old, to cover it with the latter, and to leave untouched for 24 to 72 hours. It was noted that the collection covered in this way was considerably larger when the whole process was carried out under observation than when left to the syces and mehtars. On one particular day the pile was found to be conical in shape, and whilst it had nearly 3 feet of old manure deposited on the top, in several places on the sloping sides there was less than an inch of covering.

From this it was learnt that the manure to be dealt with must be of uniform thickness, flattened on the top, and the margins well defined. Some form of simple indicator is also required to ensure the covering of old hot manure being of a sufficient depth all over (at least 18 inches). During the period several temperature observations were taken, but the surface temperature never exceeded 62°C., whilst at deeper levels it was still lower. Larvæ were found in large numbers in places registering between 50° and 62° C. Fresh manure, after standing for a short time, was found to have a surface temperature of 19° to 22° C., and a deep temperature of 23° to 26° C.

The heap was inspected four days after the camp was vacated and larvæ were only found with difficulty. On the whole, the method works well but requires a lot of supervision and careful attention to detail.

83. **Blanchard's method.**[5]—Blanchard points out that fermentation is caused by anaerobic organisms which form carbonic acid and other gases irrespirable by the maggot. The larvæ soon make tracks for the bottom or sides of the heap. They dislike light so they remain dormant some little distance from the outside during the day, but if the heap is examined at night it will be observed that they escape at the sides and, falling on the ground, bury themselves therein. They beat a particularly rapid retreat from those parts of the heap where, in order to encourage the movements referred to, a certain amount of moisture is added. Nothing is easier than to bring about these conditions.

A rectangular trough is constructed of cement, etc., 4 inches deep, 22 feet long and 12 feet wide In this receptacle a platform is constructed in the form of a grid, shorter and narrower than the trough in which it rests. It is supported by wooden uprights fixed in the bottom of the trough. In one of the sides of the latter is an orifice allowing any liquids to flow from the trough to a neighbouring cistern, also made cement-lined and measuring 5 feet by 6½ feet by 4 feet deep. A pump is fixed in this cistern.

Manure is placed on the platform and daily additions made. For the first few days the new deposits are watered. The water penetrates through them and falls into the trough which presently becomes full and is emptied into the cistern. A certain amount of liquid, however, must always be left in the trough, else the larvæ will manage to climb the walls and escape. Disappointment will also follow if there is any neglect in removing debris of all kinds which may fall from the heap. When the cistern contains a certain amount of liquid it is no longer necessary to water the heap. Instead, it is doused with the liquid manure by means of the pump and this aids fermentation processes. By whatever method the larvæ reach the periphery they take the fatal plunge into the trough and there are drowned, and are ultimately drawn off into the cistern. Others will be eaten by birds which visit the trough. The water in the cistern may require oiling in a mosquito-infested district. [Plate 5.]

84. **Additional anti-fly measures.**—If for any reason close-packing manure fails to prevent the appearance of larvæ in the heap,

the surface of the manure (sides as well as top) should either be puddled over with a four-inch-thick layer of clay, or clayey soil, mixed with water and smoothed off with spades; or covered with a layer of sacking soaked in heavy oil and weighted down with stones After the lapse of a week the sacking may be removed without risk of breeding re-commencing.[6]

A crude tar or creosote oil such as green tar oil or neutral blast furnace oil gives better results than crude mineral oil. If simply watered on, 1 gallon will suffice for 100 square feet of surface.[7]

Another useful adjunct is to lay larvæ traps. Square ration tins are used. These have slits made in all four sides at a level of about 2 inches from the bottom; the slits are kept open by means of a pebble placed inside so that the upper edge overhangs the lower. The tins are then filled with about 4 inches of sand or chaff and are embedded in the manure so that the slits are on a level with the surface of the manure. On wet nights the tins require covers. Over 5,000 larvæ may be caught in one trap in a night [8]

Adult-fly traps (see section 190 *et seq*) should also be set in the vicinity of manure heaps.

85. **Incineration.**—Incinerators are dealt with later. No pattern will deal with manure that is heavily charged with water or sand. Incineration to be successful must be carried out *at once* and each day's output must be entirely consumed within 24 hours. This however is often impracticable in wet weather and also on account of sufficient incinerators not being available. The incinerators themselves require constant attention and any material which may fall through the grids without being consumed, must be raked out daily and burned, otherwise secondary foci of fly breeding will be established.

Litter thus burnt provides often the only fuel available in camp for the incineration of other waste products and, if wet or sandy, arrangements must be made to dry and riddle it first. The litter after being collected from the lines should be spread out thinly for from 6-8 hours. The bare ground should not be used, but boards, or corrugated iron sheets if available. The latter retain the heat of the sun and not only form efficient dryers but also can be erected as roofing when rainy weather is prevailing.

86. Some data.—The litter from 100 horses requires a drying space of about 45 square yards.

Two men can riddle the dried litter of 130 horses in one hour.[9]

A horse produces 20 lbs. of litter per diem if it does not leave camp.[10]

87. Regulation.—Litter should not, except temporarily, be deposited nearer than 600 yards to an inhabited building.[11]

Burial.

88. Disposal of waste matter by burial is an improvement on surface disposal, as, if properly carried out, it fulfils the condition that no offence to sight and smell is created Though on field service it is often a matter of expediency, it should not be lost sight of that burial constitutes a biological method of treating waste organic matter.

The process of disintegration,—chemical, bacterial or by the action of the inhabitants of the soil,—takes however a considerable time to be completed. Little change is effected in one month and, depending on the nature of the soil, the total period may be from 4 to 6 months In view of this, in practice it is necessary to abandon for future use all ground which has previously been used for burial

89. Objections to Burial.—The practice of burial is not without many objections. Principal amongst these are .—

(*a*) Unless well covered with earth and often specially treated, burial pits or trenches are frequently sources of fly-breeding.

(*b*) Water supplies, such as wells and surface springs, may be grossly fouled by drainage of the sub-soil water from the region of such pits.

(*c*) Prior to being filled in, pits are often offensive and attractive to flies.

(*d*) The process of excavation entails much labour and often is not possible in rocky ground.

(*e*) The level of the subsoil water may be so high as to preclude burial.

(f) The formation of trenches, such as are used for human excreta, is wasteful as regards ground space, and in perimeter camps is practically impossible.

(g) Pits, etc., may easily be flooded by storm water.

90. Suitability of Burial.—Burial is most suitable when :—

(a) The material is not readily combustible, *e.g.*, carcases, corpses, kitchen grease, tins, pots, etc

(b) Incineration is impracticable owing to lack of fuel, wetness of fuel, or shortness of the halt.

(c) For military reasons when smoke is to be avoided

(d) When there is a sufficient trained personnel to ensure thoroughness of burial.

(e) Where the ground is composed of loose soil capable of easy excavation, the space unlimited, the ground slope favourable as regards water supply and the latter is either independent of wells or from a safe source, and in the case of open trenches, the prevailing wind will not blow from these in the direction of troops.

Fæcal trenches.

91. The first principle in the use of any form of trench is so to construct it that the surrounding ground is not fouled. If this occurs, then infective material may be carried back into the living area by human feet or flies.

Two main systems of trenches are now used in military life :—

(i) Shallow trench.

(ii) Deep trench.

(i) *Shallow Trench.*

92. The dimensions of this are 3 feet by 1 foot, and 1 foot is the regulation depth for each day's use. A width of 9 inches is more convenient for the Indian.[12] In India, to provide a sufficient covering of earth when re-filled, 2 feet should, where circumstances permit, be the minimum depth for trenches used only for one day. The following points should be carefully studied :—

93. Site.—Regulations lay down that trenches should be constructed at least 100 yards from water supplies and kitchens, preferably

to leeward and not in or near gullies which, when it rains, discharge into the water supply, nor in any situation the drainage or filtration from which may possibly reach and so pollute the water supply.[13]

Where bodies of troops are camped or bivouacked close together, the general position of the latrines and kitchens of each area will be settled by superior authority, in consultation with the senior medical officer : that is to say, it will be decided whether they are to be in front, at the rear, or in the flank of an area.[14]

In perimeter camps "the position of night latrines must be arranged in accordance with the requirements of the tactical situation, but whenever possible they should be outside the perimeter, under charge of sentries. Day latrines must be further away but within the line of pickets.[15] This last order is at variance with that laid down in F. S. Regs., Part I, Section 143(2) which states that the night latrines should, whenever possible, be inside the perimeter. The former regulation is, however, preferable, though rarely possible on the North-West Frontier.

The considerations, then, are military as well as hygienic. In any case trenches should not be dug indiscriminately around or in different parts of a camp, but within a definite area, commonly described as the conservancy area, in which all latrines, urinals, absorption pits, incinerators and swill tubs should be located,[16] with the sweeper establishment adjacent.

Surface drains should be cut around this area if flooding by storm water is anticipated.

The area in standing camps is usually indicated by a yellow rectangular flag with a central circle, red for British and black for Indians.[17]

94. **Space.**—If the space is unlimited, it is as well to guard against placing the latrines at the start too far distant from camp, or making too free use of the land. Latrines sited far from camp lead to greater difficulties in supervision and further a tendency arises, principally on the part of followers and others, to avoid this area and to foul the ground more adjacent to the camp. This habit of the follower of indiscriminately fouling the ground is one which calls for special measures and, in particular, latrines for this class should be erected at the earliest possible opportunity on the arrival of troops at any camping ground.

If the trenching space is limited, greater use must be made of it by deepening the trenches in the first instance and secondly by rigid adherence to careful planning and measurements, based on the following data.

Given that the surface dimensions of each trench are 3 feet by 1 foot, the requirements will be on the following scale :[18]—

1-500 men	5 per cent.
500 and over	3 per cent.

Economy of ground is effected, further, if the area demarcated is rectangular.

95. **Trench construction.**—Trenches should be commenced first at the side of the area most distant from the camp, the first trench being cut in a corner of the rectangle, 3 feet from the back line and 1 foot from the side. The next trench is cut leaving the same space behind and 2½ feet of earth between it and the adjacent trench, and so on until the requisite number has been completed. When new trenches are required, these should be cut midway between the old ones which are then filled in. Subsequent trenches are cut by extending the same line if frontage is available, and if not, then in front of the old trenches, leaving one foot interspace. [Plate 6, Fig. 1.]

As some form of screening, *e.g.*, salitas, brushwood, etc., is usually required, unnecessary re-erection of this will be avoided if the trenches are cut in the above manner. Screening should be carried round the sides to at least 6 feet in front, the entrance being single and in the centre and provided with a six-foot overlap to ensure privacy.

In digging trenches, much future trouble will be avoided if attention is paid to certain points :—

(*a*) Grass, if present, should be removed, if possible, as one sod and placed at the back of the trench.

(*b*) Soil excavated should be heaped on this in one mound, stones being thrown out.

(*c*) Right angles should be maintained in the excavation so as to give more space in the trench, and also trenches should be parallel and at right angles with the base line. This ensures 9 inches of firm soil as a foot-rest on either side of the trench when a second series is cut in between the first.

(*d*) Throughout construction, the non-commissioned officer in charge of the fatigue party should have handy a 3-foot stick, notched at 1 foot and $2\frac{1}{2}$ feet. Another useful time-saving device is a length of string knotted at the requisite measurements, which, stretched along the base line, indicates at once where pegs may be driven and the whole party commences work at once. Sample trenches cut by an experienced soldier are soon departed from by the novice, if the eye alone is used as a guide.

Trenches deeper than 3 feet are impracticable to construct with ordinary shovels.

96. The Trench in use.—Trenches cut 3 feet deep may be used for 3 days, those 2 feet deep for 2 days.

Each time the trench is used, the occupant of the stall must be made to shovel in a small quantity of earth from the heap at the back of the trench. The amount should be just sufficient to cover the excreta. The sweeper from time to time should sprinkle crude kerosene oil into each trench. 5 per cent. Cresol solution or equal parts of cresol and crude kerosene are also effective as fly repellents. Lime is not so efficacious.[19]

Small G. S. shovels, one per 2 trenches, should be provided for shovelling in earth as the use of the boot or foot is not satisfactory. Failing these, scoops can easily be improvised from kerosene oil tins,[20] whilst a very simple shovel can be made from a foot-length of female bamboo, split longitudinally and roughly shaped.

Paper for British troops is a sanitary necessity, and should be provided in a covered box or receptacle so that it is kept dry and does not blow away. When used, care should be taken to cover with soil for the latter reason.

For Indians an *abdust* place or places is essential. One or more soakage pits (see Section 141) should be constructed within the screened area, and loose soil strewn around. This soil should be swept into the pit daily by the sweeper A special water-receptacle should be provided, preferably outside the screened area so that sepoys and others may be seen filling their receptacles at this and not at unauthorized watering places.

In the prevention of dysentery it would probably be valuable if troops could be prevailed upon to use heavily-permanganated

water from this main receptacle. In the case of British troops, permanganated water should be insisted on for the washing of hands after the use of latrines, etc.

97. **Police arrangements.**—Latrine areas must be regularly policed by a member of the regimental sanitary detachment, to see that each man carries out instructions, that the sweepers apply disinfectants, etc., that there is a sufficiency of latrines, that old ones are properly filled in, and that the area is sanitary. His tour of duty should not be longer than 2 hours.

The conception that the inspection of latrines to determine their cleanliness is the duty of the medical officer is an erroneous one and should no longer be entertained. Inasmuch as the prevention of disease is his concern, his duties will carry him from time to time to this area, and from his inspections sanitary (or in other words, hygienic) recommendations may be made to his Commanding Officer. The detection of gross uncleanliness or disobedience of sanitary orders does not however require an expert eye, and for this reason this work is primarily the work of the sanitary police. It may also be noted that it is the duty of the Orderly officer to make routine inspections of latrines at least once a day, *vide* Manual of Elementary Military Hygiene, Section 60(12). As with all other military matters, the health and comfort of the men are primarily the care of the Platoon or Company Commander.

98. **Filling-in of Trenches.**—When trenches are filled in, which should be when accumulations reach within six inches of the ground level, the remaining soil should be replaced, crude kerosene sprinkled over this (2 pints per square yard), the whole rammed down and finally the sod, if cut, re-laid.[21]

Old latrine sites should be marked with the letter L made with stones, staves or other suitable material.[22]

N.B.—Experience on the North-West Frontier shows that shallow trenches should be avoided if possible.

(ii) *Deep Trench.*

99. There can be little doubt that in India deep trenches are superior to shallow ones as they are much more capable of being rendered fly-proof. They are also preferable where for military reasons trenches must be nearer to camp than 100 yards.

They are a necessity in trench warfare, and in sandy deserts where shallow trenches cannot be dug and, even if specially constructed, would soon fill up with drifting sand. In a perimeter camp or a beleagured garrison, such trenches can be constructed close up to the living areas and rendered perfectly hygienic.

They may be used either directly as latrines or as dumping pits, where tins or pails are used as filth receptacles.

100. **Objections to deep trenches.**—The objections, however, are as follows:—

(*a*) They are unsuitable where rapidity in providing latrine accommodation is important, *e.g.*, on the march.

(*b*) The labour involved is often heavy—large rocks being usually encountered below 3 feet.

(*c*) The level of the sub-soil water is more likely to be reached than in the shallow trench. This is not necessarily an objection as, if only a foot or so of water lies at the bottom of the pit, it aids septic tank action. Construction is rendered more difficult and the danger of contaminating wells must not be lost sight of.

(*d*) Revetments, covers, etc., are necessary, whilst railway sleepers, iron rails, corrugated iron, and timber generally may be scarce or unobtainable.

101. **Construction of Deep Trench.**.—The dimensions naturally vary according to circumstances. A convenient size is one with inside measurements, exclusive of any revetment, 9 feet long, 3½ feet wide and 8 feet deep. Every foot extra depth obtainable is an advantage as these pits are filled in when within 3 feet of the surface.

The soil excavated should be heaped on one side only, giving some measure of cover, shade or protection from prevailing winds. Revetment is unnecessary in stiff soil. If sandbags are used, a trench of the above measurements will require to be dug in the first instance 13 feet long and 7½ feet wide and then be revetted with bags measuring 20 by 10 by 5 inches. Some 650 bags will be required. In deserts, revetment can often be done by struts or wattle more economically.

To prevent maggots which develop in the depth of the pit, boring into the sandbags, working their way to the surface and pupating an inch or two beneath the surface of the ground, some form of fly-barrier is required. The best method is to line

the whole pit with sacking stretched on wooden frames and soaked in crude mineral oil. Failing this, an area 2½-3 feet in width around the mouth of the pit should be covered with strips of closely-woven sacking soaked in oil. The method of laying this is clearly shown in Appendix II, Plate 7.

The pit is next boarded over, more light sacking or paper put down and soil thrown over the same to render the pit fly-proof. If used as a dumping pit only, the boards and sacking should be removable, to enable a fresh place to be used from time to time and ensure the pit filling evenly. If the pit is used directly as a latrine, gaps for latrine seats or stances must, of course, be left in the boards. The space between seats should measure about 3 feet.

102. **Provision of Seats or Stances.**—For British Troops, if sufficient wood is obtainable, an all-wood box should be constructed with self-closing lids. The seats may either be single or double on the 'back-to-back' principle. Ingenuity is required in devising self-closing lids, the general principle being that the wooden lid is prevented from being raised to a vertical position by a 'chock or stop' behind, and so falls under its own weight when released. The stop behind should be sufficiently high to prevent it acting as the fulcrum of a lever whereby pressure on the lid may cause the hinges to be forced. The best hinges consist simply of an iron rod working loosely at its ends in two screw hooks in the seat. [Plate 7 and Plate 22, fig. 2.]

The holes in the seat should be pear-shaped: stress may be laid on the measurements of these as they are smaller than is generally thought. The depth from back to front should be 11 inches, and the width at 3, 6 and 9 inches from the front of the opening should be 5⅞, 7¾ and 7¼ inches respectively. The front of the opening should be not more than 3 inches from the front of the box seat. Comfort is added if the upper edge of the opening is bevelled off smoothly. A space of ¼ inch should be left at the seat hinges to allow for swelling of the wood, which invariably follows rain or the use of liquid disinfectants. A tin shield should be fixed underneath the opening in front to direct urine into the pit. Circular holes are less comfortable but are rapidly cut with a compass saw.

It is as well to remember that in rainy weather when the seats are wet, men avoid sitting down and the seats quickly

6 inches in cross section, all round it; saturate the earth taken out with solution "C" (see section 111), or 5 per cent. cresol, and then replace; lastly, cover the trench and surrounding area to a distance of 6 inches beyond the furrow with a 3-inch thick layer of puddled soil.[25]

Filth receptacles.

104. The shallow and deep trenches described have, by reason of the fouling and wastage of ground during lengthy occupations, often to be abandoned in favour of the much cleaner method of pail-removal and incineration. It need hardly be pointed out that this latter system is at all times preferable but requires much more apparatus.

A short description is given of the various appliances which can be improvised as filth receptacles.

105. Urine-separating devices.—(*a*) *For British Troops.*—A seat consisting of a stout pole and supported at intervals on forked uprights, is erected with a fall towards one end of 2 inches in 10 feet. A small drain is made out of biscuit tins, etc., or strips of galvanized iron sheeting, and is nailed to the posterior surface of the pole. The free edge of the drain or trough projects about 4 inches behind and is about 4 inches lower than the upper surface of the pole. This drain opens at its lower end into a pit or receptacle. When in use, faeces drop dry into buckets whilst the urine is caught in the drain and carried off for final disposal.[26]

This device is much improved if another pole is erected behind and parallel to the first, and planks are fixed across shaped to form seats. (Plate 9.)

(*b*) *Improvised system combining incineration on the spot.*—This system, which has at times worked very well, was devised so that each individual should burn his own excreta and dispose of his own urine immediately they are passed. The system has, however, been condemned by many as being impracticable and insanitary. The latrine pans are made from biscuit tins and the incinerators from paraffin drums. (Plate 10.)

A thin concrete or puddled-earth platform may be made for the tins to stand upon. This should be 1 yard wide of the required length. 12 inches between seats is allowed for British troops where individual screening is not essential. If rough seats are not provided (and many consider that the squatting position is

much more hygienic [27]) bricks or pieces of wood to indicate the position of the feet, will tend to ensure that the separate tins for faeces and urine are correctly used.

Pieces of newspaper are placed in the rear tins and each man does this before he leaves the latrine. Failing this, grass, hay, straw or old rags will do equally well. When the latrine is used, each occupier empties the urine from the front tin into the soakage pit and then takes hold of the four corners of the newspaper and places it and its contents into the incinerator. A fresh piece of paper is placed in the tin ready for the next user.[28]

Various difficulties, however, arise. The incinerator must be kept burning; paper is often scarce and may blow about; supervision is essential; and finally,—an important point often forgotten—faeces are frequently of liquid consistency under field service conditions of life.

Each day the tins are washed out with cresol solution and the outsides brushed over with a mixture of cresol, oil and water. The platform is swept and disinfected. Incinerators are relighted in the morning. The construction of these is described in section 132. For Indians greater supervision would be required and an *abdust* place provided at the urine pit.

(*c*) *Perforated latrine pans.*—Latrine tins may be perforated and placed over small trenches filled with broken brick and sloped towards a urine pit. Liquids run off through the perforations and the solids remain for burial or incineration. The broken brick, however, gets quickly fouled and will require to be taken up, burnt and re-laid.

(*d*) *Box latrine.*—The materials required for the construction of this are an empty wooden ration biscuit box for preference, or other box complete with lid or a thick square piece of wood—2-3 inches thick—with a circular opening in it to serve as a seat; an automatically-closing lid to cover the whole; an empty six-gallon drum; two empty five-gallon cresol drums; and a small piece of thin wire. (Plate 11.)

The diameter of the seat opening should be one inch less than that of the cresol drums. Two re-inforcing bars of wood should be nailed on the inner aspect of this opening sufficiently far apart to permit of the oil drum fitting between them. This prevents lateral movement of the seat. A lid is made from the opposite side of the box, of such a size that it covers the greater part of

the seat and thus prevents it getting wet in rainy weather. This is hinged on by leather or other hinges and should be so fitted that it drops automatically over the seat. An elastic recoil is obtained of discarded motor tyres are used as hinges.

The top of the six-gallon drum is next cut out. The seat rests on the brim of this and thus prevents access of flies from without. Two "V"-shaped notches are cut on each side of the drum diametrically opposite, 2 inches apart and ¼ inch deep; *i.e.*, just sufficient to admit the wire handles of the inner drum next described.

The two cresol drums are cut in half or a little deeper; the top parts are discarded and the bottom parts are used to serve as inner or faeces trays which are slung by means of wire handles. These drums are of special shape. A part of the side is bent in so that the upper brim presents a "reniform" instead of a circular outline. From the brim to the bottom of the tin this part, which is bent in by thumb or hammer, is moulded to form what is called the 'urine flush,' as it is down the outer side of this tin that the urine passes to the drum beneath.

Two wire handles are made for each inner drum and should fit exactly into the notches cut in the outer or urine drum. The large six-gallon drum is now placed on the ground, one of the cresol trays slung inside it and the seat with lid placed on top. Tin envelopes to hold paper, cut from biscuit tin, are attached to the sides of the box and an overlapping tongue provided to keep out rain.

The cresol tray (or faeces tray) should fit the posterior half of the outer or urine drum very closely, and should be slung so as to be not more than 2-2½ inches from the level of the brim of the outer drum. Straw, dry leaves, sawdust, paper or oil may be placed in the bottom of the faeces drum. A few drops of pure cresol are placed in the bottom of the urine drum. Two mops of sacking should always be at hand with a little cresol solution, for cleansing drums and trays.[29]

106. Pail substitutes.—(*a*) *Cresol and Paraffin Drums.*—As the diameters of these are rather small, openings should be cut in their length, one-third of the circumference being removed. Sink the drums in the ground nearly level with the cut edges.[30]

(*b*) *Biscuit tins.*—These are not altogether satisfactory as a large percentage of tins leak badly and, being frail, they very

quickly get out of shape unless supported. Strengthen by fixing a wooden fillet round the top and provide a wire handle.[30]

When required portable, as for night latrines in perimeter camps, some standing camps and rest camps, or in trench warfare, receptacles should be mounted in boxes or provided with lids as shown in Plate 6, fig. 2, and Plate 12.

Disposal of refuse.

107. Broadly speaking, there are only two methods of disposing of refuse; *i.e.*, incineration or burial, of which the former is preferable. It will be convenient to discuss this problem here and set out the various orders relating to the subject.

The refuse of a camp consists of general rubbish strewn about tents—kitchen garbage, bits of crockery, tins, paper, rags, etc Litter from animal lines has already been dealt with, whilst the problem of disposing of the carcases of animals follows in section 110 *et seq.* Finally, there is another type of refuse which causes much trouble in camps; *i.e.*, offal from abbatoirs This is too wet to be burnt and often large amounts have to be dealt with.

For general rubbish, special receptacles should be provided. In temporary camps holes may be dug, but these should be covered with at least 6 inches of earth three to four times a day. They should be located near kitchens and at the end of each line of tents, and a notice put up " Rubbish to be thrown here " in English and vernacular. In more permanent camps all this garbage and refuse should be placed in closed receptacles, the contents of which are removed and disposed of daily. In the absence of closed receptacles, general refuse may be collected in sacks which are hung on posts placed at the end of each line of tents. Kitchen garbage can be collected in tubs, barrels, boxes, etc., which need to be raised on stands close to the cooking places.

Solid and liquid refuse should never be mixed unless necessity compels The supervision and management of all refuse receptacles is a part of the duties of the regimental sanitary detachment. The final disposal of kitchen garbage and camp refuse is a matter of great difficulty. Even in standing camps it is far from easy. The location of the place or places for final disposal should always be outside the inhabited area and placed to

leeward of prevailing winds and remote from the source of water supply.[31]

108. Regulations.—The regulations on this subject are as follows:—Refuse of all descriptions should be burnt daily and what cannot be burnt should be buried.[32] In a recent campaign on the North-West Frontier this dictum was questioned, it being found that burial caused fly-nuisance, whereas spreading was less obnoxious.

Refuse, stable litter (offal and carcases) should, whenever possible, be burnt. In all camps incinerators can be improvised to facilitate this. In other cases they will be buried as far from camps as possible When circumstances permit, the utilization of incinerators for the burning of litter and refuse should be combined with the burning of excreta from the latrine When incineration is employed for the disposal of excreta, an incinerator should be located close to the latrine it is serving [33]

On outposts refuse pits must be prepared.[34]

In camp and bivouac refuse pits, etc, must be situated at least 100 yards from, and when practicable to leeward of the water supply and kitchens.[35]

Slaughtering places should not be near horse lines [36] They should not be put near Hindu troops and should be screened from view.[37]

109. Method of final disposal.—Refuse, and especially kitchen refuse, is best burnt in a Horsfall or other closed drying incinerator (see Incineration). Failing this, one of the small type incinerators, the cross bars of which should not be set too wide apart, should be used.[38]

When pits are resorted to, a 3-foot cube is a convenient size In dealing with offal, abbatoirs should first be placed well away from living areas and the offal and blood disposed of in large pits, the contents of which should be treated by the same anti-muscid measures as are adopted for latrines, particular attention being paid to the formation of an anti-maggot area by soaking the soil thrown in with kerosene, and ramming down hard. (See section 103)[39]

Data.—An average man in average soil should excavate 30 cubic feet in the first hour and 80 cubic feet in four hours' continuous work.[40]

Disposal of carcases.

110. Incinerators for burning dead animals, etc., should be constructed in standing camps and rest camps.[41]

The carcases of dead animals should be removed from any ground likely to be wanted for camping, disembowelled and the viscera buried deeply. In standing camps the carcases should be burnt or buried.[42]

Carcases should whenever possible be burnt.[43]

The above are regulations and directions for dealing with this subject. The problem, however, is an extremely difficult one, often solved in India when the vultures have completed the task. The burial of the carcase of a horse or camel is a most laborious proceeding; it must be deep to prevent excavation by jackals.

The following procedure has been recommended:—A hole is dug beside the body which is then disembowelled and the viscera are buried and well covered. The carcase is dragged over the buried viscera and blood-stained soil. Into the body-cavity and over the surface, 30-40 lbs. of dry grass or litter soaked with one quart of kerosene are distributed and set alight The exposed surfaces are sterilized and charred, whilst the ground also becomes sterilized, which is very necessary when an animal has died of infectious disease such as glanders, anthrax, etc. No attempt at incineration is made in this case but only charring, after which the body affords no attraction for flies. In burying carcases, the intestines must be opened freely, so that gases will escape and not force open the covering earth.[44]

111. Experiments on putrefaction.—The following summary of a series of experiments conducted to find a means of arresting putrefaction, and the conclusions arrived at,[45] may be of value to the officer who meets this problem afresh. They resulted in the official use, during trench warfare, of a fluid termed "C Disinfecting Fluid."

In carcases true putrefaction or disintegration is preceded by—

(*a*) early gas formation, mainly due to the action of intestinal organisms on the carbohydrates of the intestinal contents and tissues.

(*b*) Exudation of fluid, probably due to the effects of cytolysis and enzyme action.

(c) Green discoloration of the skin which appears to be connected with the effects of hydrogen sulphide or organic acids on the blood pigments.

Even under weather conditions very favourable to putrefaction, small carcases exposed in the open can be preserved for months. Treatment of the skin with Creosote oil prevents external conditions from nullifying any antiseptic properties which the injected fluid may possess. It also repels flies and preserves the carcase from the attacks of maggots. Excellent preservation of the body can be obtained even when the abdominal cavity is opened and the organs exposed, provided the peritoneal surfaces and skin are treated with this oil. Good results were also obtained when a very dilute solution of arsenic was injected, amounting to a concentration of 0·046 per cent. in the water of the body.

The following table shows the results of various reagents :—

Reagent	C c of reagent *injected* per lb body weight	C c. of Creosote oil per lb of body weight used *in skin treatment*	State of preservation
10 per cent HCl	10	21	Moderately well preserved
1 per cent Arsenic acid	14	15	Perfectly preserved.
1 per cent $HgCl_2$ in 5 per cent NaCl.	18	20	Moderately well preserved.
5 per cent $K_2Cr_2O_7$.	21	18	Do do
Creosote oil . .	9	15	Perfectly preserved

The type of creosote oil described is coal tar creosote oil, "country make" 14-18 per cent. tar acids. Coal tar oils at full strength kill maggots immediately. Best is creosote oil. Anthracene oil is less effective. The potent constituents are contained mainly in the fractions which distil over at a temperature below 240° C.

* For general use as an inhibitor of putrefaction, deodorant, repellent of flies and destroyer of maggots, the addition to creosote oil of the above type of sufficient bases derived from

"light oil" to make the proportion of phenolic bodies to bases two to one, is recommended and this fluid is termed "C Disinfecting fluid."

The presence of water seems to enable maggots to resist the toxic action of phenolic bodies to a large extent. Emulsions containing only 5 per cent. phenolic bodies do not kill maggots in 15 minutes, whilst feeding on meat soaked in such emulsions does not harm them.

Bodies, whether opened or not, can be preserved for several weeks by thorough treatment of the *exposed* surfaces by creosote even in the presence of rain or soil water. Large carcases can be preserved in the same way as small ones if combined with *injections*. Removal of the abdominal organs is disadvantageous as it leaves more exposed surfaces and tissues. In carcases so treated, all contained eggs and maggots are killed. Eggs will, however, be deposited on them after 2-3 weeks and thus such carcases act later as traps. Any stage of decomposition may still be arrested by the use of creosote oil

The benefit to be derived from C disinfecting fluid, particularly in trench warfare, if used in sufficient quantities is very great. Bodies are mummified by its action and rendered inoffensive even after and during a shower of rain. It is a very definite fly repellent and will kill adults in great numbers with quite small quantities from a spray. The moment they are touched by the minute droplets, they soon die.

A carcase that cannot be disposed of immediately should be sprinkled over with this mixture by means of a watering can and the fluid distributed in the direction of the hair by means of a hard brush. When one side, including the extremities, has been treated, the carcase should be turned over and the other side treated. Small quantities should be poured into the eyes, ears, mouth, anus, and any wounds. About ½ gallon suffices for this and another ½ gallon is required if the thoracic and abdominal cavities and gut are opened , but this usually is not necessary.

Two men can easily treat a horse thus in 15 minutes. The carcase will be preserved satisfactorily for some weeks, after which local supplementary applications may be necessary. Injection by the carotid artery is easily accomplished but is not usually necessary. It will add some months to the length of preservation Putrefying bodies should be sprayed from a distance after which the stench will be at once reduced.

Fresh horse manure exposed for 24 hours and sprayed with 4 gallons to the ton, gives satisfactory results as regards abatement of fly nuisance. Such amounts of creosote do not apparently have any injurious effect on the manure as such, and do not interfere with processes responsible for the increase of temperature in a manure heap.

Precautions—The liquid is an irritant and it is well to wash the hands after use. It burns the face slightly if left on, so protective glasses should be worn by men using the spray. The liquid is extremely inflammable and very great care must be taken to extinguish all naked flames before use. The flash point is 193-200° F.

INCINERATION.

112. **General principles.**—With any of the ordinary incinerators using as fuel the material which accumulates daily, the liquid refuse of the day, such as urine, cannot be disposed of by evaporation without accumulation resulting, even if the fuel is supplemented with litter, bhoosa or oil.

On the daily average each person contributes to the latrine bucket 4½ ounces of faeces containing 3 ounces of water; and 5 ounces of urine passed with defaecation, which ordinarily is inseparable This gives a total of 8 ounces of liquid per person which has to be disposed of daily.

Incineration to be successful must take into account certain scientific facts, principle amongst which is the essential that the combustible material must have a sufficient caloric value to dispose of itself plus the moisture which requires evaporation. As the ordinary combustible material available in a camp has not this caloric value, it is a waste of time and energy to devise incinerators which claim to dispose of all the urine in addition to solid matter.

A battalion 1,000 strong provides 600 lbs of filth a day in the latrine buckets, 500 lbs., of this being liquid and 100 solid The fluid of 60 lbs. of this can be absorbed by 10 lbs. of sawdust and the regiment therefore requires 100 lbs. per diem of absorbent matrix of the equivalent value of sawdust, to take up the liquid.

The total fuel of *the caloric value of sawdust* which is required to incinerate completely the 500 lbs. of liquid is 330 lbs. As the total combustible refuse from the standard unit averages 1,500 lbs. per diem, the unit should be self-supporting in its incineration and this has been found to be the case. At most, all that is needed extra a day, if the ordinary refuse be found insufficiently absorbent, is 50-60 lbs. of sawdust or its equivalent.

In practice, dried horse litter provides the best supplementary fuel and it may be noted that 2 lbs. of this give enough fuel for the incineration of the faeces of one man in rough camp incinerators of the closed type.

In the light of these data it may be said that the contents of filth buckets in fixed camps can be economically burnt if a suitable incinerator is used, but that some other means must be found for dealing with urine *not passed as defaecation urine.*[46]

Types of Incinerators.

113. There are two main types of incinerators, the open and the closed. Objections to the open type are that they are :—

Slow to make and start.

Wasteful of fuel.

Productive of offence.

Liable to be put out by rain.

The contents blow all over the camp.

For these reasons open types should never be used if closed patterns are available. On the other hand they can be improvised from materials always at hand and the portable varieties, consisting only of a grid and supports, are cheap and light. The draught, however, is little, so that the contents merely smoulder and this imperfect oxidation gives rise to more offensive odour.

Open types.

114. Camp Incinerator (Rectangular).—Built of turf-sods or bricks Sufficient air inlets are required at the base. Disused meat tins, kerosene tins, etc., with tops and bottoms removed, make good frames for these openings. The draught is improved by making a heap of stones 13 inches high in the middle of the

incinerator. The best dimensions are 4 feet long, 4 feet wide and 4 feet high.[47]

115. Camp Incinerator (**Beehive**).—An old type incinerator, similarly constructed to the above but the diameter should be 5 feet and the height of the wall 3½ feet.[47]

116. Camp Incinerator (**Stones**).—Dig a saucer-like depression in the ground 10 feet in diameter and not more than 2 feet deep in the centre, shelving gradually to the level of the ground at its circumference. Line the whole with large stones or broken bricks and build a low wall around, heaping up against it on the outside the excavated earth. Finally build a pyramid of stones in the centre to reach 2 feet above the level of the encircling wall. Start the fire with dry wood or brushwood. The stones, once hot, help to dispose of liquid and damp refuse with rapidity.[47] At best this type is suitable only for general refuse, *e.g.*, litter, condemned bhoosa, etc.

117. Crematory.—Where boulders, large stones or broken bricks are not procurable, a crematory can be made of empty tins of all kinds. Stack these radially in heaps about 4 feet high and pile up the miscellaneous rubbish on and around them. On vacating camp, these tins should be buried.[47]

118. Camp Incinerator (**Wire Frame**).—A large ironwork trough 4 feet deep and 4 feet wide and of any length is constructed from bale bands, wire, etc. The mesh should not be more than 5 inches square. Place it broadside to the wind, raised 2 feet from the ground.[47] Suitable for manure, litter, etc.

119. Improvised Refuse Destructor.—Dig two shallow trenches intersecting each other at right angles; each trench should be 9 inches deep and 9 inches wide where they cross, getting gradually shallower and wider towards the ends. The length of each trench need not exceed 5 feet. Over the angles of intersection, a chimney 3 feet high and 3 feet in diameter must be built of turf sods or bricks. To support the walls of the chimney where they cross the trenches, iron bands off bales or barrels may be used. The fire is lighted with dry material at the bottom of the shaft and fed steadily by throwing rubbish and refuse down the top.[47]

120. Camp Incinerator (**Grid-type**).—If ordinary rails are available in any quantity, a grate or grid can be made by arranging a dozen rails each 10 feet long as a circular cone with the upper

ends securely lashed together by a stout wire, and the lower ends placed on the ground so as to form a circular base some five feet in diameter. Around the central pyramid of rails, grates are arranged radially. These grids or grates are made from other lengths of rail resting on low turf or brick walls about one foot high The radiating grids are joined together by lengths of rails. This arrangement will dispose of enormous quantities of manure litter and even faecal material.[48] It is, however, wasteful of rails, only suitable for a permanent camp and has all the objections of open incinerators.

121. **Circular Brick Incinerator.**—The number of bricks required is 184. The diameter at the top is 20 inches, at the base 36 inches and the height 46 inches. Bars are fixed 15 inches from the ground, $2\frac{1}{2}$ inches apart. The bricks at the base are arranged with their lengths radially. The fourth and subsequent rows are then laid flat, not radially but in a rough circle, the diameter of which gradually diminishes with each row. An opening at the base, 12 inches wide, is left and the bricks over this must be supported by some sheet iron. The width of the space between bricks at the base is 5 inches on the outer circumference and 3 inches on the inner.

An iron cover can be improvised and used in wet weather. The openings left between the bricks should be in alternate rows, with the 4th and 5th rows completely closed. If double walls are provided, 400 bricks are required, the height being 39 inches, internal diameter at base 45 inches and at top 24 inches.[49]

The incinerators described so far are scarcely satisfactory and are mostly only suited for temporary camps.

122. **Fixed Inclined-plane Incinerator.** (Plate 13).—This simple but effective incinerator can be made out of four kerosene tins, cut and joined as shown in the diagram, and arched over an inclined plane built of stones or tins and plastered over smoothly. The side flanges of the tin cover are embedded in the plaster, which is then heaped over the outer surface of the cover. Refuse is tipped in at the top of the half-cylinder thus formed, and is prevented from sliding down by a series of long nails embedded in the plaster. If made tail-on to the prevailing wind, this adds to the draught. If the wind blows in the opposite direction, a tin plate placed across the feeding hole, but a foot or two away,

induces an aspirating action which is also effective. Two such incinerators can deal with all the organic refuse (save fæces) of a regiment for some weeks in a dry hot climate.[50]

123. Portable Inclined-plane Incinerator.—(Plate 14.) This pattern arose after trial had proved the value of the principle embodied in the last-mentioned incinerator; *i e.*, that the choking of combustion by ashes in vertical incinerators is largely prevented by a sloping platform in which the ash falls, while the flames pass obliquely upward above the ash level.

The diagram explains the construction; the holes left by cutting and turning down V-shaped tongues, form triangles with 2-inch sides through which ashes fall and air rises. These holes should be made in rows 6 inches apart, at the bottom of the curves of the corrugated-iron plane. Tapping the plane shakes the ashes out and the contents down. The plane can be inclined to any required angle and can also be turned tail-on to the wind. The whole folds flat and there are no detached parts.[50] Another open field incinerator is figured in Plate 15.

124. Permanent types.—More permanent constructions include the Raitt pattern and Mhow pattern open incinerators. With regard to both these and the improvised types it may be asserted definitely that they will not deal with the amount of fluid which it is essential to dispose of: secondly they will not work in rainy weather unless covered, the combustion is not under control, they are dangerous from dissemination of infection by the wind and at all times they give rise to offence.[51]

Closed types.

125. The principles to be aimed at in closed incinerators are several. Firstly, to utilize the heat of the furnace for the preliminary drying of faecal refuse, which when dry and combustible is raked over into the fire. Secondly, as the evaporation of the liquid portion leads to the evolution of obnoxious gases, the chamber should be so arranged by the insertion of a baffle plate that these gases pass over the fire before being aspirated into the chimney. Thirdly, by scientific planning and minimising inlets, the greatest draught possible must be obtained.

The term 'destructor' has now become synonymous with 'incinerator'; formerly it was applied to large city destructors which by dealing with vast quantities of trade refuse and waste,

rendered it possible to insert boilers and obtain steam which is utilized to promote a forced draught through the furnace doors.

For incineration to be successful, however, much depends upon the manner of stoking and even the best pattern destructors may cause offence or break down entirely if left to haphazard care. The faults of the stoker are many In the first place owing to the labour involved, he scamps the collection of supplementary fuel such as litter, peat, brushwood, etc. The fire, allowed to die out overnight, is re-started in the morning and the excretal contents of pails are added before the furnace is sufficiently hot. Irrespective of the state of the furnace and draught, he then adds large quantities at stated intervals during the day, instead of judiciously feeding the furnace with smaller amounts and maintaining it at an even temperature. Laziness again dictates that the furnace doors are left open when the draught is lost. The sudden drop in temperature caused either by the addition of large quantities of refuse or by leaving open the furnace doors, leads to incomplete combustion and this is evidenced by the sudden emission of clouds of offensive smoke. Ignorance of the principles of combustion on the part of the sweeper is a justifiable plea and for this reason every effort should be made to supervise his work and train him to a state of efficiency.

126. **Types of closed incinerators.**—Closed incinerators are either portable or fixed No satisfactory portable incinerator has yet been used in India though the two described later are efficient as regards incineration. Other considerations, however, are of great moment to an army in the field and not least amongst these is the additional transport which the provision of a portable incinerator to each unit would necessitate. For this reason it is unlikely that future enterprise will be directed towards perfecting apparatus of this kind. There is, however, a possible future for a small blast incinerator using oil fuel under pressure, and experiments recently have been initiated along these lines.

At present reliance is placed on ingenuity to construct in the field fixed pattern incinerators from material locally available. One essential for any incinerator is the provision of fire-bars and as these can rarely be obtained locally and wire, bale bands, etc., constitute most unsatisfactory substitutes, they will ordinarily be supplied, as required, by Engineer Field Parks. The

standard bar measures roughly 4 feet 6 inches and is of ¾ inch square iron.

Portable field incinerators.

127. Bethuen's Grenadier pattern.—With this incinerator nested pans are used. These are made of ⅛-inch sheet iron, the tops lined with wire, and are constructed in nests of six, the largest being 9 inches by 14 by 5 inches deep. Two sets of nests fit into an iron box with cover, and four such boxes were designed for the use of a regiment. The load is compact and suitable for mule transport These boxes have two uses.—

(*a*) To hold excreta until the incinerator is working.

(*b*) To hold disinfecting solutions for the cleansing of pans after use.

Small gunny screens, 2 feet high and 15 feet long, divided into 5 compartments approximately 3 feet square, are provided. The incinerator is designed to be portable, strong, not too heavy, durable, not too expensive and to work efficiently. It is 2 feet square at the bottom, 2 feet high and 1½ feet square at the top. The construction is simple and the incinerator can be made of ⅛-inch sheet iron with hinges of ⅜-inch round bar iron. There are 8 fire-bars of ½-inch round bar iron. The quarters are joined together by 3 slots and studs and the incinerator is well ventilated with side vents. It is placed over a hole dug 1 foot deep and 1 foot square, which assists ventilation and receives the ashes.

The weights are :—Incinerator 54 lbs. ; 4 receptacles with pans and oil cans 50 lbs. each, 8 iron bars 18 lbs. ; screens and pegs (unnecessary) 140 lbs. ; and implements 11 lbs [52]

128. Lelean's portable incinerator.—This is a closed incinerator weighing 56 lbs. The additional pan and latrine accessories weigh 38 lbs. The incinerator is a 2 foot cube mounted on four legs composed of 4 sheets of flat iron hinged to a grid, upon which they fold for packing. To the roof is hinged a chimney which also folds up for transport and fits into the roof concavity. The life depends upon the fierceness of combustion as the thin side-plates soon burn through.

With regard to both the last two incinerators, it may be said that they have had little place in recent warfare.

Fixed, permanent and improvised, closed incinerators.

129. Early Indian patterns.—The original pattern was that designed by Hawes. Improvements on this resulted in the Sialkot pattern This consists merely of a furnace in which the mixed fuel and excreta are burnt together and the fumes are led off by a chimney The latter are often very acrid and offensive and the heightening of the chimney, though improving the draught, only extends the pall of smoke over a wider radius. A certain amount of this nuisance is avoided by splaying out the chimney to form a chamber and retard the draught.[53]

Mention has been made of urine-evaporating devices. The Wellington and Meerut patterns were pioneers in this respect, but apart from the main objection already discussed, overfilling of the urine trays often floods and extinguishes the fire.

A great many varieties, most of them modifications of the Sialkot pattern, exist in India. A recent design, *i e.*, the Gell pattern, is egg-shaped and aims at economising fuel, producing a central draught, and obviating raking whereby unburnt particles are forced through the fire-bars. In its present stage it has not proved very satisfactory In the Mhow double-pattern large incinerator the principle differs little from that of the Sialkot, the main feature being that there are two chambers communicating with a central flue

The Jhelum pattern presents new features. This is constructed underground which not only seems to increase the draught obtained but facilitates the emptying of pails from the ground level. A central compartment placed between two incinerating chambers is used for drying litter. (Plate 16.)

Some incinerators which have met with success may now be described in more detail.

130. An underground type.—(Plate 17, fig. 1.)—A funnel-shaped hole is dug in the ground, the upper diameter 3 feet and lower 1½ feet. The depth of the hole is at first 2½ feet, which is later on increased to about 3½ feet by piling up the loose earth excavated in digging the hole. The inner surface of the cone should be covered with mud and well hammered, or in permanent camps lined with brick work. At its lower end, the earth cone opens into an iron bucket supported on a flange. This bucket receives the ashes and can be removed for emptying : on the top of the

bucket there is a grid-iron on which the fire is built. The bucket is contained in an excavation which must be lined with stones to prevent the earth falling in. A cast-iron pipe opens into the bucket to allow a free supply of air to the fire. A conical iron cover, made in separate pieces for convenience of packing, covers the whole. This has a trap door through which rubbish is fed into the fire. The weight of the iron apparatus is about 2 cwt.[54]

131. Beehive type.—The main principle is the provision of a subterranean airspace for draught, a central air cone and, at the level of the top of the air cone and close to it, a perforated tray for burning faeces.

The walls are constructed of brick, stones, etc., cemented together with a mixture of clay 5 parts and cow manure 1 part, the addition of the latter making a mixture which binds well and to some extent limits cracking by heat.

The airspace below ground saves a large amount of building material. The dimensions are 5 feet diameter at the base and 5 feet high. The excavation is made 1 foot deep and the walls are built up from the ground level. A grating of hoop-iron is provided at ground level and on this rests in the centre the air cone, 1 foot in diameter at the base, 9 inches at the top and 1½ feet high, constructed from hoop-iron. At the level of the top of the air cone, iron bars are carried across the incinerator and rest on the top of the cone. On these bars rests a circular faeces tray made from sheet-iron (*i.e.*, cresol drums) 2½-3 inches deep and 1½ feet across (see Plate 18).

This is perforated with small holes. A chimney is built centrally and the usual vents, two or three with shoots leading to the tray, another for stoking, another for raking the bars and removal of tins, etc., and finally one for removal of ashes, are constructed at their respective levels.

The fire is started by combustible material mixed with manure and old tins and when burning freely, faeces are added into the tray.[55] This incinerator was originally designed for use with a field hospital. Another improvised beehive incinerator (open type) is figured in Plate 21, fig. 1.

132. Incinerator constructed from paraffin drums.—The following are required:—a barrel (minus bottom) or built-up outer

frame, two old paraffin drums (minus bottoms); cement, sand or shale; and pieces of scrap iron.

The paraffin tins form a model for the cement jacket which should be about 4 inches thick, consisting of 1 part cement and 5 parts sand. When finished the incinerator should stand about 30 inches high but as a paraffin tin is only 17 inches high, it is necessary to place one tin end to end with the other. At the point where the tins join and about 12 inches from the ground, some pieces of iron should be passed through so as to form a grid for the tin to rest upon when working. When the cement dries the tins should be withdrawn, one up and the other down.

It is now necessary to cut four oblong holes in the bottom of the cement jacket, front, back, and both sides, for draught purposes; the front hole being larger than the other so as to provide facilities for cleaning out. A bottomless paraffin tin is placed on the grid inside the jacket, but this must be cut from top to bottom so that heat will not cause the tin to expand to such a point that it will crack the cement jacket. When making the jacket, strengthen it with pieces of old iron or wood. When finished, whitewash. The paraffin drums should project for an inch or two above the top of the jacket to prevent the edges of the latter being chipped when the contents of the trays are emptied into the incinerator. (See section 105(*b*).) One such incinerator suffices for the excreta of 1,000 men in 24 hours, and one is allotted to every ten sets of trays or trenches.[28] (Plate 10.)

133. A small faeces and rubbish incinerator. (Plate 19.)—This is an oblong box without a bottom, shaped like a sarcophagus, approximately 5 feet long by 2½ feet high and 2 feet broad. It is built of sheet iron bolted together with rivets and nuts. A grid is made by riveting a length of T-iron along the sides in the long axis of the box, about one third of the way up from the bottom. These irons support the bars which form the grid The bars are loose, measuring 2½ inches by $\frac{3}{16}$ths inch, each of the required length.

At one end an aperture is cut to admit draught and allow of raking out ashes. The cover, flanged, is made 2-3 inches shorter than the box so as to form a flue at the top and opposite end of the box from the firehole, and is provided with wire handles for lifting. The incinerator is turned so that the firehole faces the wind.[56]

134. Combined incinerator and drying-room.—(Plate 20.)—The main body is built of brick and mud. If bricks are unobtainable rough stones will answer quite well. The front measures 3 feet across, back to front $3\frac{1}{2}$ feet, and height to base of chimney $3\frac{1}{2}$ feet. The bottom of the fire consists of four or five iron bars. At the level of 3 feet high, an iron plate (rolled-out oil drum or piece of corrugated sheet-iron) extends from back to front leaving a space at either side, and this is supported by two iron bars running crossways. The roof, six inches higher, is also supported by iron rods.

There is only one inlet for air, on the ground level in front beneath the fire-bars. An opening immediately above the air-inlet and fire-bars is similarly constructed and lined with a biscuit tin This is for raking the fire and removing tins, and is closed by rough door. A circular opening lined with half an oil drum, with lid fitting closely, is provided near the top still higher up the front wall but beneath the iron plate. This is for feeding in the dry camp refuse. The wall in front, above the iron plate, is sloped inwards and provided with another inlet, covered with a plate of iron. Through this inlet faeces are inserted. These collect and dry on the iron plate and, when dry, can either be raked over the sides of the plate into the fire beneath, or left to char to clinker. The chimney is placed centrally and consists of two oil drums.

Such an incinerator develops a fierce draught and will even melt glass. It burns the excreta and refuse of over 400 men in 2 hours.

Drums built into the back and side walls will provide hot water. Drums built inside the body of the incinerator can be used as urine evaporators. 110 gallons have been boiled off in one day from such an incinerator.[57]

If the back of the incinerator is built projecting into a shed 15 feet long, 10 feet wide and $6\frac{1}{2}$ feet high, with an entrance at the opposite end, and the chimney (built by fitting together oil drums) be taken backwards into the room, then down to the floor level, along the room and finally upwards to a vent in the roof, a very efficient drying room is procured. The door should be protected in cold weather by a small porch, whilst a small ventilator is required in the roof and clothes-rails along each side of the room.[58] A similar fixed incinerator is figured in Plate 21, fig. 2.

135. Combined Incinerator and Water Heater.—(Plate 17, fig. 2).—An iron barrel of 18 gallon capacity is first obtained. Some paraffin kegs are of this capacity. The incinerator is best made up with bricks: two lateral masses $3\frac{1}{2}$ feet long by $1\frac{1}{4}$ feet wide, three bricks deep, with a space between $\frac{3}{4}$ foot in width, are first built and the gap at one end then closed. Firebars are then placed on these and the brickwork continued up for about 5 layers. In front, a space about 1 foot square is then allowed for, to act as a fire-door, and at the sides the walls are built up to about $2\frac{1}{2}$ feet from the ground, when the barrel is placed in position with its ends resting on the lateral walls. The brick-work is continued up and over to surround the vessel completely, leaving only an opening for the bunghole of the barrel and another 9 inches square as a chimney at the opposite end from the fire-door. If the chimney is built up a foot or so, a better draught is obtained.

The dimensions when complete are:—base $3\frac{1}{2}$ feet by $3\frac{1}{2}$ feet by $4\frac{1}{2}$ feet high. The hole is puddled with clay and a rough door is made to insert into the fire-door opening. The barrel where it protrudes laterally at one side is provided with a tap.[59]

136. Adjuncts to any incinerator system.—(*a*) *Refuse dump.*—Without a refuse dump sweepers, to save labour, will feed the incinerator indiscriminately and by over-firing with damp refuse cause much smoke and delay incineration.

The dump should have a prepared ground-surface and be enclosed on all sides leaving only a small entrance facing the incinerator. Turf, wood, clay or wire-netting may form the walls.[60] (Plate 13.)

(*b*) *Refuse pit.*—This is required for the ashes of the incinerator. When finally covered with earth, the usual six-inch layer of rammed earth soaked in kerosene should be made[60] Too great stress cannot be laid upon the necessity for careful cleansing and raking out of incinerators, as accumulations in and around of unburnt material, which has fallen through the bars, lead often to fly-breeding.

DISPOSAL OF LIQUIDS.

137. The liquid refuse of a camp consists of:—

Urine, human and from animal lines

Kitchen sullage water and grease.

Ablution and laundry waste water, containing soap.

Disposal of urine.

138. The disposal of defaecation urine has already been discussed and there remains to describe the various methods by which the balance may be disposed of.

Evaporation being impracticable except in certain high-temperature destructors, there remain :—

(*a*) Open trenches.

(*b*) Closed soakage pits.

139. Open Trenches.—An old type of camp urinal takes the form of one or two shallow trenches, at least 2 feet wide, leading into a pit filled with large stones. The trenches are for urinating into and the pit takes the excess urine which fails to soak into the soil. Two trenches, each 8 feet long, will suffice for 1,000 strong. They should have a fall of one inch to the foot. The catch pit will vary in size according to the soil and number of men using the trenches; one 3 feet deep and 8 feet in diameter in a moderately porous soil should suffice for 800-1,000 men. The trenches last about 2 days and the pit some 8 days. When foul, new trenches can be dug as radii from the pit and the old ones filled in. They should be screened.[61]

(*b*) In temporary camps the above will suffice but can be improved upon as follows :—Dig the pit square, 3 feet by 3 feet, and 4 feet deep, the bottom being picked loose and holes picked in the sides. Heap all the soil on one side only. A square pit gives a greater absorbing surface than a circular one. The first trenches are cut at right angles to each other and parallel with the sides of the pit, and meet at one corner, slightly tapering so that not more than 9 inches of each side of the pit are cut away. Stones may be omitted from the pit except those excavated which should be thrown in at the bottom. The pit is thrice-daily sanded over with excavated soil and the ground strewn daily with straw soaked in kerosene, and the latter burnt and swept into the pit.

140. Objections to open trenches.—Where occupation of a camp is at all lengthy these urinals are very unsatisfactory. They entail much labour in construction, become very foul and attract

numerous flies. Furthermore, as night urinals are usually provided close to the tents at night, consisting of cresol drums or biscuit tins, and the contents require emptying in the morning, the pit, used directly for this purpose, soon becomes clogged.

Another objection to this form of trench is that men stand on one side and urinate across it. One side of the trench gets sodden and this leads to a tendency to stand further and further from the edge with the result that an increasingly wider surface of ground becomes fouled. Flies have access to large quantities of infective urine. Trenches are in reality unnecessary and by their abolition and the covering of the pit, much offence is avoided. The pit now becomes a soakage pit.[62]

141. Soakage pits.—The principle of these is throughout the same and the only variations lie in the devices employed to cover the pits and to act as urinals. The pit is conveniently cut as a 4-foot cube and the bottom soil loosened. It is then filled nearly to the top with empty tins or graded stones, the smaller ones being at the top. Tins, if used, should first be burnt and perforated.

For British troops, completion of the pit is effected as follows:—when a suitable height is reached, four funnels, 4½ feet long and tapered from a diameter of 6 inches at one end to 2 inches at the other, are inserted obliquely at each corner. More stones are packed around and finally a layer of brushwood, grass or sacking, timber or corrugated iron is laid on top and earth spread over. Each funnel should be made fly-proof with a strip of old mosquito netting or mul-mul cloth; failing these, a light plug of grass may be inserted.[62] (Plate 22, fig. 1.)

For Indians, half cresol drums cut longitudinally, or biscuit tins, etc., perforated should be let into the pit at the ground level. There is no particular point in moving funnels or receptacles to fresh parts of the pit.

The ground around should be sprinkled with 5 per cent. cresol or kerosene twice daily, and funnels, etc., smeared with crude oil.

142. Objections to soakage pits.—There are several objections to soakage pits, some theoretical and some practical.

(*a*) The first common objection is that the pit will not work if, in wet weather, the ground is saturated. This objection, however, must apply equally to the trench system of disposal.

(*b*) The pit drains off surface water and becomes waterlogged. This can be avoided by cutting surface drains around the pit.

(*c*) The sub-soil water and so the water supply, if from wells, becomes contaminated. Provided care is taken to locate soakage pits so that the subsoil water is directed from wells towards the pits, this objection, in practice, does not hold good and the measure is a reasonably safe one Furthermore, though regulations state that urinals should not be nearer than 100 yards to any cookhouse, well, etc., there is with this class of fly-proof soakage pit no particular reason why they should not be close up to tents, etc., and thus avoid the use of night urinals in the form of tubs.[62]

143. **Alternative methods of disposal.**—In certain districts, notably Nowshera, the subsoil is clayey and absorption therefore cannot take place. In such cases it must be decided whether it is better to go on constructing pits which act simply as reservoirs or, at best, evaporation pits, or to remove urine to a considerable distance and either spread in shallow trenches or sprinkle on the ground, trusting to the heat of the sun to promote and complete its evaporation.

Before such a measure is carried out, endeavours must be made to sterilize all urine in view of the great danger of fly carriage of infection.

144. **Sterilization of urine.**—Two points in connexion with urine should be borne in mind. Firstly, urine contains a high percentage of organic matter and, secondly, rapidly decomposes with the formation of ammonium hydrate. Consequently, where bleaching powder is used as the sterilizing reagent, much greater quantities are required than are used in the purification of water supplies. Experiments go to show that fresh acid urine requires 1 dram of 33 per cent. bleaching powder to 1 gallon; when the urine is stale and alkaline, it should first be acidulated with hydrochloric acid and the quantity then required is 6 drams to 1 gallon.

145. **Urine receptacles.**—(*a*) A convenient form of urinal is made by slinging chloride of lime or other tins from a pole which is raised at each end on trestles supported by guy ropes and pegs. A wooden tray to hold cinders, etc., is placed below to catch drops which may fall to the ground. The tins swing gently in wind and are easily emptied into larger camp receptacles.[63]

(b) Night urinals in the form of cresol or other sound tins must be placed at frequent intervals near tents or bivouacs. They should be painted white or whitewashed to render them visible at night At times a lamp may be allowed. For British troops they should be raised on a plinth so that the top of the tin is 2 feet 3 inches from the ground. For Indians they may be sunk into the ground.[63]

Apart from the regulations already quoted with regard to latrines, two more[64] deal with the provision of night urinals and the prohibition against urinating elsewhere than in the places provided

Disposal of sullage water.

146. Grease removal.—As sullage water must be disposed of in. or on. the soil, the first essential is to free it from emulsified fat. If this is not done and the water be run into pits, the sides rapidly become clogged with fat which prevents any absorption of the remaining water and new pits have to be dug frequently.

Many of the older camp sanitary devices recommend the use of grass, bhoosa, bracken or brushwood for straining the fat from sullage water but these materials are of very little value. The best material, and one usually obtainable, is sand. [See Plate 23, fig. 2.] Several devices are now described:—

147. Kitchen grease traps.—(a) A pit 3 feet cube is dug with a surface trench leading into it, 9 inches wide 9 inches deep and 5 feet long. At the end furthest from the pit is placed a tin containing hay, with an outlet at the bottom leading into the trench. Inside this tin is placed a smaller one perforated at the bottom and containing hay, tea leaves or sawdust. The trench itself is lined with flat biscuit tin and filled with brick or cinders broken down to walnut size. The greasy water deposits its fat mainly in the tins, and also on the broken brick. Both pit and trench are covered over to prevent fly access. Every alternate day the brick is removed and the fat burnt off in the incinerator. It is then replaced.[65]

(b) A wooden box is made 4 feet long, 2 feet wide and 3 feet deep. A partition is fixed 8 inches from one end and reaching from the surface to within 3 inches of the bottom. The whole box is then filled with material graduated from below upwards in the following way:—12 inches broken brick of walnut size, 6 inches broken brick of pea size, 3 inches sand and then a

covering of hay. The water percolates down through the filter, beneath the partition and up the other side to the outlet, whence it runs into a soakage pit. When the sand becomes greasy and clogged, which it does very quickly, the surface is scraped off and fresh sand added The hay is burnt daily.[65]

(c) A similar device can be made from half a wine barrel or stout box, preferably tin-lined. A wooden cover should be provided. Cut a hole 5 inches from the top and fix in a jam tin as spout projecting over a soakage pit. Hammer out flat several biscuit tins and fix vertically as a partition, one third of the diameter distant from the spout, nailing it to the sides from the top to within four inches of the bottom. A biscuit tin with perforated bottom is set in the lid sloping obliquely outwards so as to facilitate the emptying of the contents of kitchen receptacles. Fill up the barrel with water and place hay or sawdust in the tin. The grease must be periodically skimmed off the surface and burnt.[66] (Plate 23, fig. 1.)

148. Factors for success.—The desiderata for success are:—

(i) That the water contained in the trap shall be of sufficient quantity that it rapidly cools the hot greasy water put into it, otherwise baffle plates, etc., will fail to act.

(ii) The inlet to such a trap must be of sufficient size to allow of the emptying of large cauldrons without spilling.

(iii) As the inlet is perforated and rapidly chokes, it should be removable.

(iv) The water in which dishes are dipped to remove the grease must be boiling and kept so during the dipping process.

(v) The bulk of this latter water must be kept as small as possible.[67]

149. Soap removal.—Whether pits are used or, on account of a clay substratum, surface disposal is resorted to, soapy water should be clarified before final disposal. Many devices have been employed, some depending on filtration only and others on chemical treatment as well.

(a) Water is made to pass from the ablution place through a biscuit tin containing hay, into a pit filled with broken brick. From the bottom it rises through a second pit also filled with broken brick, whence it flows through surface drains filled with rubble or cinder, either directly into a ditch or on to a patch of

ground prepared by digging up the surface one foot deep. A second patch of ground is prepared when the first becomes waterlogged—the two being worked alternately.[68] (Plate 24, fig. 1.)

(*b*) A soap trap suitable for standing camps consists of a stout wooden box 4 feet square and 2 feet 4 inches deep, divided vertically into 6 compartments—four filled with straw and two with coke, brick or suitable material—providing alternate downward and upward filtration. From the box, the effluent discharges through a pipe into a boarded pit 5 feet square and 4 feet 9 inches deep, containing 3 inches of coke, etc., covered with 9 inches of sand.

The floor of the pit slopes to a small central chamber 13½ inches square, formed of one layer of loose bricks covered with wood or tin. The water from the box falls on to a board resting on the surface of the filter and is thus distributed over the surface without disturbing the sand. After passing through the filter it drains into a catchpit, whence it flows through a discharge pipe into a ditch or pond.[68] (Plate 25, fig. 1.)

(*c*) A modification of the above is more suitable for the field as the trap can be dug in the ground and requires a fall of only 2½ feet: the cumbersome box is also avoided.

The dirty water passes through a tin containing hay into a trench 6 inches deep and 3 feet long; at the end of this it passes through a second tin of hay, the sides of which are perforated back and front. Thence it passes into a pit 3 feet square and 4 feet deep.

A wooden partition wall, reaching from the surface to within six inches of the bottom, divides the pit into two compartments connected at the base. The water passes down through 2 feet 3 inches of broken brick and 1 foot 3 inches of coarse rubble in the first compartment, and up through 1 foot 3 inches of coarse rubble and 2 feet 3 inches of fine ashes in the second. It then passes into another pit through a pipe.

The second pit is 2 feet 6 inches deep with a slight fall to the outlet pipe which leads to a pond or ditch. The effluent should be made to fall into this last pit preferably in the form of a spray. The floor of the pit consists of a tray of perforated tin resting on a final filter bed composed of 6 inches of sand over 3 inches of broken brick and the outlet pipe should be protected by a

small catchpit made of loose bricks covered with tin.[68] (Plate 24, fig. 2.)

150. **Chemical methods of soap removal.**—The following method is described to indicate the chemistry of clarification. The soapy water from the wash-house is led first into a mixing tank. Slaked lime is placed in this tank and thoroughly mixed by means of a windmill mixer constructed from a couple of old bicycle wheels and a pole. When the wind fails, mixing must be done by hand but this is hard work. The lime throws down the soap as insoluble calcium stearates. The effluent runs through three up-and-down settling tanks, placed all on the same level. These are built of brick with cemented floors. The partitions are removable wooden frames with canvas centres. The three settling tanks are respectively 3, 4 and 5 feet wide. This gradual widening of the tanks tends to retard the flow of the stream, thereby assisting precipitation. All the calcium stearates will be found to have settled down in the first two tanks. (Plate 26.)

The third tank is used for precipitating the lime and removing the soapy oils. This is effected by means of washing soda which is run into the tank from a drum containing a saturated solution of sodium carbonate. This precipitates the calcium salts—chiefly hydroxides—as insoluble calcium carbonate which immediately falls to the bottom of the tank. In addition to this the sodium carbonate causes the soluble oils from the soap to separate out. These oils, which give the water an odour of soap, float on the surface and are absorbed by means of canvas or sacking nailed on to wooden frames. The canvas is changed daily.

From this third settling tank the water flows into a charcoal filter containing four inches of powdered charcoal between two layers of sacking. Through this filter it runs into a bricked concreted well or reservoir. The first precipitating tank is cleaned out every 3-4 days and the mixing tank daily. Sludge is buried. It shows no tendency to decompose. Water treated thus gives a good lather again with soap, is clear and free from dirt, soap, lime and soapy oils, and so can be used an indefinite number of times. The only extra water required is that amount necessary to replace the loss caused by cleaning the tanks. A charcoal filter 6 feet square deals with 4,000 gallons a day.[69]

(*b*) Another device, suitable where the effluent cannot be run into pits, is to run the soapy water into a chamber where chlori-

nation is carried out, automatically or otherwise, and then to pass the effluent into a barrel through a pipe which passes down to within 6 inches of the bottom. This barrel is painted inside and out with crude oil and well caulked. The overflow pipe passes to a second barrel of similar design and to the same depth. The overflow from this last barrel passes to the ground level,—stream, ditch or irrigation beds. Both barrels contain layers, from below upwards, of gravel, coke, charcoal, coke, gravel, coke, gravel. No scum forms in the barrels owing to the use of bleaching powder.[70] (Plate 27.)

(*c*) Soapy water, after treatment in a baffle-plate trap, can be clarified considerably by the use of alum. A saturated solution of potash alum containing approximately 10 per cent. of the crystalline salt or 5.5 per cent. of the exsiccated salt, is the strength used.[71]

151. Final disposal of sullage water.—When not run directly into a stream or pond, waste water must eventually be either run into soakage pits or be disposed of by broad land irrigation. For the latter process a sloping land surface is preferable. The ground should be divided into areas and, after use, be allowed a day or two to dry. Channels or *nalas* must be cut along the contours, one below the next and so on, so that the water which is passed into the uppermost channel overflows and runs down the slope and is caught by the next channel. In sandy places radiating shallow trenches can be scraped rapidly and used in rotation, the sand being occasionally scraped. Land or sand should be dry before being re-used.

152. Fat recovery.—There are times when the recovery of all available fat from food refuse may require to be made. All meat and bone refuse from meals should be collected and thrown into a metal cauldron and treated with steam under pressure. This may be done on a small scale by passing steam from a boiler into a covered refuse cylinder containing the waste material and skimming off the fat periodically. On a large scale the cauldron consists of a metal vat provided with a heavy cover which can be clamped down. This iron receptacle forms the lining of a brick reservoir. The cauldron is filled with refuse and steam enters under pressure through a side pipe. The fat rises to the top and is drained off in a liquid state by a pipe passing through the iron and brick, into petrol drums or kerosene oil tins from which it is emptied into ordinary wooden barrels. Fat is used

in soap-making and a by-product, glycerine, is used in munition factories.

153. Kitchen furniture.—A very convenient form of washing-table for mess tins and degchies is one consisting of a sheet of corrugated iron, 10 feet by $2\frac{1}{2}$ feet wide, mounted on a trestle at one end and sloped towards a grease trap. At the other end a sand box is provided [72] (Plate 25, fig. 2.)

The above is a more sanitary device than the camp bench improvised from poles and mounted on trestles standing over a platform, which is composed of rammed earth and is sloped inwards to a central drain or trench leading into a soakage pit.

154. Materials used for cleansing cooking utensils.—The use of earth must be persistently discouraged. When sand is used, it should first be baked over a fire and then stored in a clean tin. Where wood ash is used, it is important to see that the arrangements for preparation, collection and storage are sanitary.

REFERENCES.

[1] Lelean; Sanitation in War, p. 149, 261.

[2] Makgill; R.A M C. Journal, Vol. 27, p 121.

[3] Roubaud; R A.M C Journal, Vol 26, p. 107.

[4] Blackmore; Annual Sanitary Reports, India; 1917, p. 78

[5] Blanchard; R A.M C. Journal, Vol. 26, p. 248.

[6] Lelean; Sanitation in War, p 148.

[7] Lefroy; pamphlet "Measures for avoidance, etc." p. 6.

[8] Marett; R A M.C. Journal, Vol. 25, p. 456.

[9] Lelean; Sanitation in War, p. 146.

[10] Lelean; Sanitation in War, p. 221

[11] Q M.G., India, Circular No 15, dated 19th August 1907. Standing Orders, Mil. Med Services. India p. 167.

[12] Tilbury Brown; R A M.C Journal, Vol. 20, p. 323.

[13] F S Regs. I, 60 (3). F S. Pocket Book, II, 10 (8), 10 (9). Man. of El.Mil Hygiene 60 (2); Med. Man. (War) India, 29 (5).

[14] F. S. Regs I, 56 (6), Man of El. Mil Hygiene, 57 (2).

[15] F. S. Regs. I, 155 (4); Man of El. Mil. Hygiene, 57 (3).

[16] Mil. Engineering, Part V, section 22.

[17] F. S Pocket Book, Plate 21

[18] Military Engineering, Part V, section 22.

[19] *Cf.* F S. Regs., I, 60 (4).

[20] Man of El. Mil. Hygiene, Chap X, 60 (11)

[21] Man. of El Mil Hygiene, Chap. X, 60 (13).

[22] Man of El. Mil. Hygiene, Chap X, 60 (13). F. S. Pocket Book, II, 10 (9).

[23] Brooke Pike, R A M C. Journal, Vol. 26, p. 335.

[24] Lelean ; Sanitation in War, p. 151.

[25] Lelean ; Sanitation in War, p. 153.

[26] Sharp ; R.A M C Journal, Vol 25, p 349.

[27] Military Surgeon, Vol XLII, No 3, p 346

[28] Macpherson ; R A.M C Journal, Vol 25, p 398.

[29] Mackenzie ; R A M C Journal, Vol. 27. p. 767.

[30] Brooke Pike ; R A M C Journal, Vol 26, p. 331.

[31] Man of El. Mil Hygiene, 58 (1) ; 68 (1), 68 (3). R.A.M C. Training, 132 (1).

[32] F. S Pocket Book, Chap II, 10(4)

[33] Med Man. (War), India. 29 (6).

[34] F. S. Regs , I, 75 (18).

[35] F. S. Regs., I, 60 (3) ; 63(3).

[36] F. S. Pocket Book, Chap II, 10 (8)

[37] F. S. Pocket Book, Chap. II. 8 (18).

[38] Mem. on some Med Dis in the Med. War Area, 1917, p. 121.

[39] Lelean ; Sanitation in War, p. 218.

[40] Lelean ; Sanitation in War, p. 216.

[41] F. S. Regs.; I, 63 (4).

[42] F. S. Pocket Book, Chap. II, 10 (4)

[43] Med. Man. (War) India, 29 (6) ; Man. of El. Mil. Hygiene, 59

[44] Lelean ; Sanitation in War, p. 230.

[45] Graham Smith ; Journal of Hygiene, Vol. 16, p 177, 221 etc Lancet, Vol CXCII. (i) 1917, p 354.

[46] Lelean ; Sanitation in War, pp. 218-221.

[47] Man. of El. Mil. Hygiene, Chap. X, 68 (7).

[48] R.A.M.C. Training, Section 132 (vi)
[49] Dewberry; R.A.M.C. Journal, Vol. 22, p. 86 ; Vol. 24, p. 480
[50] Lelean, Sanitation in War, pp 263, 264.
[51] Lelean, R.A.M.C. Journal, Vol. 17, p. 352.
[52] Bethuen, R.A.M.C. Journal, Vol. 15, p. 574.
[53] Lelean, R.A.M.C. Journal, Vol. 17, p. 347.
[54] R.A M.C. Journal, Vol. 14, p. 569.
[55] Timca; R.A.M.C. Journal, Vol. 26, p. 98
[56] Holt, R.A.M.C. Journal, Vol 26, p. 241.
[57] Mackinnon; R.A.M C. Journal, Vol. 28, p. 377
[58] Mackinnon; R.A.M C. Journal, Vol. 29, p. 330
[59] Moxey and Scott-Williamson, R A.M C. Journal Vol. 24 p. 385.
[60] Brooke Pike; R A.M C. Journal, Vol. 26, p 343.
[61] R.A M.C. Training, Section 136.
[62] Lelean; Sanitation in War, p 232.
[63] Brooke Pike, R.A M.C. Journal, Vol. 26, p. 337.
[64] F. S Regs, I, 60 (2); Med Man (War) India, 29 (7).
[65] Brooke Pike, R A.M C. Journal, Vol 26, p 339
[66] Davey, R.A.M C. Journal, Vol. 27, p 758.
[67] Carroll, R.A.M C Journal, Vol 28, p. 383, Ellis; p. 605.
[68] Brooke Pike; R A M.C. Journal, Vol 26, p 344
[69] Goode; R A M C. Journal, Vol. 27, p 370.
[70] Marett, R A.M.C Journal, Vol 29, p 210.
[71] Ellis; R A.M C. Journal, Vol 28, p. 610
[72] Ellis; R.A.M.C. Journal, Vol. 28. p. 607.

CHAPTER IV.

CAMP SITES, SPACES, TENTAGE, RATIONS, ETC.

Camp sites.

155. The selection of a camp site is dominated largely by the facilities which exist for obtaining water, particularly in regard to temporary camps. The various regulations with regard to the selection of sites have been dealt with in Chapters II and III, and it is sufficient here to indicate a few general principles.

When possible, camps should be placed on high ground. Marshes and irrigated land should be avoided and given a wide berth on account of the increased density of the mosquito population in their vicinity. Bearing in mind the necessity for pit construction, avoid where possible rocky ground and land where the subsoil water may be expected to be high, *e g.*, the dry beds of watercourses and low-lying ground at the mouths of rivers. Dryness and cleanliness are to be aimed at, for which reasons ploughed and dusty areas are unsuitable, abandoned camping grounds undesirable and land in the vicinity of intensive agriculture should be avoided on account of its propensities for breeding flies.

Whatever camping site is selected, and this is frequently decided more by the military exigencies of the situation than by the demands of hygiene, it should be a rigid rule that no form of permanent building is erected until full consideration has been given by the sanitary or other medical officer to the suitability of the surroundings.

Camp spaces.

156. The shape and the size of a camp or bivouac will, subject to certain general rules, be determined by the ground.[1]

The following data should serve only as a guide.

Indian establishment.	Ordinary camping space in yards	Contracted bivouac in yards
Army Headquarters	100×150	
[illegible]	50×100	40×60
[illegible]	30×50	30×40
Cavalry—		
Regiment (British)	160×180	105×125
Squadron (,,)	80×90	70×70
Regiment (Indian)	160×180	105×120
Squadron (,,)	80×90	70×60
Artillery Battery—		
Royal Horse or Field Artillery	80×130	70×95
Heavy	60×110	
Mountain	80×100	
Cavalry Brigade, Ammunition Column	70×40	
Divisional Ammunition Column	70×90	
Field Artillery Section Ammunition Column	155×70	
Mountain Section Ammunition Column	22×15	
Small Arms Ammunition Section, Ammunition Column	25×70	
Heavy Artillery Ammunition Column	70×70	
Engineers—		
Balloon Section	60×100	
Mounted Unit of Sappers and Miners	30×100	
Service Company of Sappers and Miners	60×105	40×80
Pontoon Section	70×130	
Infantry, Battalion—		
British	150×120	105×105
Indian	150×100	105×90
Medical—		
Cavalry Field Ambulance—		
British (one section)	85×65	
Indian (two sections)	85×72	
Combined (one British and two Indian sections)	120×100	
Field Ambulance—		
British (four sections)	101×103	
Indian (,, ,,)	101×105	
Combined (one British and three Indian sections)	101×105	
Casualty Clearing Station—		
British (one section)	85×77	
Indian (three sections)	101×127	
Combined (one British and three Indian sections)	150×130	
Casualty Clearing Station, Staging Section—		
British	85×82	
Indian	85×82	
General Hospital—		
British	710×163	
Indian	442×163	

Tentage.

157. The scale of accommodation in tents varies with the exigencies of the situation The following existing scales, the first applicable in peace[2] and appropriate for camps in Divisional Areas, and the second that laid down for field service,[3] are quoted only as a guide: no reduction is advisable without pressing reasons and ordinarily a more liberal scale of accommoation would be preferable :—

—	Summer				Winter.				Field Service								
	I P. tent	S S tent	G. S. 160-lb. tent.	G S 80-lb. tent	I P. tent.	S. S. tent	G. S. 160-lb. tent	G. S. 80-lb. tent.	Field Hospital	Officers 80-lb	160-lb. tent.	80-lb. tent.	40-lb. tent.	21-lb tent.	Indian Cavalry 45-lbs. Mark II.	Private's 900-lb. tent.	Staff Serjeant's 500-lb. tent.
British Troops—																	
In temporary camp	8	6	6	2	12	8	8	2									
In standing camp*	6	4	4	2	8	4	4	2	6	2	16	8	1†	..	.		
Hospital accommodation	6	4	2	1	6	4	2	1									
Indian Troops—																	
In temporary camp	12	10	10	5	14	12	12	6									
In standing camp	8	6	5	3	8	6	5	3	6	2	20	10	1†	.	6§		as required.
Hospital accommodation	8	6	5	3‡	8	6	5	3‡									
Followers—																	
In temporary camp	16	15	15	6	18	15	15	6									
In standing camp	14	12	12	5	16	12	12	5	..	..	25	12	..	.	..		
Hospital accommodation	8	6	5	3	8	6	5	3									

* A standing camp is one that is intended to remain pitched for 2 calendar months or longer

† Warrant officer or non-commissioned officer.

‡ Single-fly tents will not be utilized for hospital purposes in normal circumstances.

§ Silladar.

158. The considerations in allotting accommodation in tents are rarely those of ventilation but rather ground space, with occasionally the factor that charpoys or trestle stretchers may be required, together with some form of mosquito net.

When G. S. tents are used, the interiors should be exposed to the sun by throwing one side over the other. I. P. tents should be rolled up during the day when the tent is unoccupied. In hot weather, the sides of the tent are better dispensed with at night, unless dust storms are prevalent.

The following table illustrates the beneficial effect of erecting chappers over tents in reducing the shade temperature during the heat of the day, though the effect is very slightly the reverse when the shade temperature is below 90° F The observations were made in 6 stations in the Punjab during the period May to September 1918.

Shade temperature in non-chappered tent.

—	80-89°F		90-99°F		100°F and over	
	A M	P M	A M	P M	A M	P M
With chappers .	84 86	85 33	90 93	93 82	104 5	103 55
Without chappers	81 25	85 00	93 07	94 60	108 00	107 58
No of observations	(18)	(6)	(14)	(20)	(4)	(13)

Rations, food and cooking.

159. A few hygienic principles may be mentioned. Whenever possible, men should be provided with separate dining places. As cooking places must necessarily be some considerable distance from the majority of tents, etc., it is better for men to take their meals near the kitchens than in their tents. If double-fly tents are not available, some sun-proof shelter should be erected, in the shade of trees where possible, to guard against sunstroke.

The objections to men eating their meals in their tents are many. The air of the tent in which the men sleep later becomes vitiated, particularly after the evening meal when the flies of the tent are more apt to be kept closed. Scraps of food and

crumbs, etc., fall or are thrown on the ground and these attract flies and other insects. Fouling of the tent floor is very rapid by this means. Finally, the distance from the kitchen leads to meals being tepid or cold when consumed. This diminishes their palatability and contributes to the physiological defective assimilation which in any case tends to occur by the prolonged use of a monotonous diet.

Some improvised camp and field kitchens are depicted in Plates 33 and 34.

160. Food disease.—Sufficient has been said in section 245 *et seq* regarding deficiency diseases to indicate that the composition and selection of a ration is of great importance. All field service rations as laid down in War Establishments, India, contain a clause empowering General officers commanding in the field to make additions as may be necessary. The General Officer Commanding in this respect must be advised by his Director Medical Services who is his sanitary adviser. The latter must necessarily depend upon his medical officers in the field for warnings that the existing ration is proving unsatisfactory; hence it follows that not only should each medical officer take every interest in the rations of his men and see that the methods of cooking are the best in the circumstances, but also it is his duty to bring to notice of higher authority any defects in health which he may consider are arising as the result of the ration.

Amongst Indians, it is probable that the insufficient cooking of dal and rice leads to gastro-intestinal disturbances which, again, may be a predisposing factor in the contracting of dysentery, colitis, etc.

When tinned rations are once opened, the entire contents should be removed from the tin at once, and if not consumed, should be kept in fly-proof safes. (See section 200.) Badly damaged tins are better rejected.

161. Examination of tinned rations.—The exterior of the tin should not show more than two solder-holes; it is incorrect to suppose that there should necessarily only be one. The ends should be concave and dull to percussion. Gas can be detected by opening the tin under water. A good firm will supply a painted or lacquered tin and not one labelled with paper. The date of canning also should be stamped on the tin.

In the interior of the tin, solder should not project from the seams. If an unnecessarily large solder surface is exposed, the chances of lead being taken into solution are increased. The tin coating the iron of the can should be intact and the following is a useful method of testing for "pin-point" erosions :—Remove the grease from the surface by strong alkali, wash; place in dilute hydrochloric acid (50 per cent.); add strong solution of potassium ferrocyanide and leave for one hour. Minute erosions will stand out conspicuously, coloured deep blue, after the plate has been gently washed free from the reagents.

Jelly should be semi-solid at ordinary temperatures whilst the meat should be of good colour and odour and not markedly alkaline Preservatives should be absent. Blackening of the inside of the tin is not necessarily evidence of putrefaction of the contents. A slight dark film, often seen, is formed by sulphur liberated by the splitting up of proteid molecules in contact with the tin, during the process of heating the can in cooking. Heavy blackening is caused by ferrous sulphide which is formed as follows:—decomposition of meat leads to the formation of alkali and ammonium sulphide; this is converted into stannous sulphide which, being soluble in alkaline solutions, is dissolved off the interior of the can as rapidly as it is formed. The iron underlying the tin is thus exposed and converted into ferrous sulphide which is precipitated in alkaline solutions.[4]

162. Food storage.—Wherever possible, food should not be stored in tents or quarters which men normally inhabit by day or night. Apart from the attraction that food has for flies, fleas and other vermin, rats are encouraged and these may be in the first place attracted from plague-infested areas. It is of the utmost importance that fly-proof food receptacles be provided: these, where not supplied from Engineer Field Parks, are easily improvised from boxes and mul-mul cloth. (See Plate 28, figs. 1 and 2.) Mul-mul cloth at 5 yards per 100 men is authorized as an issue to British troops engaged in the protection of the North-West Frontier and can be drawn on mobilization.[5] (See section 200.)

Improvised hot and cold food-stores are figured in Plate 35.

163. Food values.—For convenience, a simplified Caloric table is given below. This shows the number of Calories per 1 ounce weight, given by some of the commoner foods in use in India.

Atta (Flour)	99 328
Bacon	179·894

In devising a suitable ration various factors must be considered, such as the climate and volume of work demanded, etc. Generally speaking, a man performing hard work requires a ration which will give from 4,000 to 4,500 Calories daily.

REFERENCES.

[1] F. S. Regs., I, 61(1).

[2] I. A. O. No. 360 of 1918.

[3] A. R., I., Vol. X, App. XII.

[4] Lelean; Sanitation in War, p. 15, *et seq.*

[5] A. D. letter No. 13298, dated 1st October 1918.

CHAPTER V.

DISINFECTION.

Disinfection of Rooms.

164. Briefly, there are two main methods of disinfecting rooms, *i e*, either by *gaseous* disinfectants or by *liquid* disinfectants. In India, the latter method is probably the better as the former demands that every possible outlet in the room must be sought for and effectively sealed. There is, further, less risk of fire and the process after completion cannot be interfered with by others.

Gaseous disinfection.

165. Sulphur.—First close all crevices. Next sprinkle the floor and walls with water, as the gas acts better in a moist atmosphere. Open all cupboards and drawers, etc, 4 lbs. of powdered or roll sulphur to every 1,000 cubic feet of air space are then ignited on a shovel or iron receptacle, placed over another receptacle containing water to prevent risk of fire Methylated spirit assists the lighting of roll sulphur. The room should then be vacated and the cracks and keyhole of the door sealed. Six hours should elapse before the room is re-entered.

Other articles requiring disinfection may be put into the room, being hung up loosely.

166. Formalin gas.—Though in towns usually generated by means of an Alformant lamp, Lingner's apparatus, Trillat's autoclave or similar special appliance, a ready method where these are not obtainable is by adding 20 c.c. (about $\frac{2}{3}$rds oz.) of formalin to 8 grams (about 124 grains) of powdered potassium permanganate. These amounts are for each 1,000 cubic feet of air space

The re-agents should be mixed in an ordinary galvanised iron pail, the permanganate being put in first and the formaldehyde solution poured on the crystals. Not more than 10 fluid ounces of the solution and 5 ounces of the permanganate crystals should be placed in one 3-gallon pail, as considerable frothing follows the mixing of these substances.

As soon as the last portion of the re-agents has been mixed, the operator must leave the room and seal up the door.

The room must be kept closed for 24 hours.

On entering the room after this period, the nose, mouth and eyes should be covered with a damp cloth. The remaining formalin vapour may be dispersed by sprinkling a few drops of ammonia around the room.

167. Hydrocyanic Acid gas.—The use of this gas has recently been adopted in India for the destruction of vermin in clothes, bedding, etc., and occasionally for ridding rooms of bed bugs. The process of disinfection is not without danger to life unless carried out under expert supervision. Fixed and portable apparatus have been devised. $2\frac{1}{2}$ ozs. of cyanide of potassium, preferably powdered, per 1,000 cubic feet, with exposure for 15 minutes, suffice for the extermination of fleas; 5 ozs. with exposure for 1 hour for bed bugs, and 10 ozs with exposure for 2 hours for body lice. Neither the cyanide nor the sulphuric acid need be chemically pure. Hydrocyanic acid gas is more penetrating and more rapid in its action than Sulphur dioxide. Where natural air currents can be obtained there is no danger to men entering a place so fumigated 30 minutes after apertures have been opened.[1]

Liquid Disinfectants.

168. These are usually applied in the form of a spray. Various sprays are well-known, *e.g.*, the Defries, Mackenzie's, Robertson's Invicta, Equifex, etc., and though not available on general service, their place may be taken by the Holder Harriden, Mackenzie or Heppel's fly-sprays provided for Sanitary Sections.

Formalin is by far the best solution as it does not decolorize or stain. Hypochlorite solutions are also used. When formalin is used, the strength should be 6 ounces to the gallon. If a little glycerine is added, evaporation is delayed and the process of disinfection is maintained for a longer period. The operator sprays first the walls, next the ceiling and finally the floor. Overalls are advisable but not essential. The face and hands should be washed afterwards.

Disinfection of clothing.

169. All articles which may safely be disinfected by steam should be so treated. The following are exceptions :—

Boots, Belts and other leather articles.—Wash well in a 5 per cent. solution of formalin. Failing this, use cresol solution 4 ozs.

to the gallon (R-W Co-eff. 12). Exposure to the hot sun for one hour or more is probably equally effective.

Blankets.—White blankets do not stand steam disinfection well, owing to the tendency of steam to fix indelibly any stain that may be present and also to alter the texture and colour of the blanket. With the brown Army blanket this consideration matters little. An alternate method to the use of steam is soakage in Cresol solution. They should never be boiled.[2]

All articles, in addition to blankets, that are steeped in Cresol solution should be exposed to the standard solution of 1½ ozs. to the gallon (if the Rideal-Walker co-efficient is 12; if 18-20. then 1 oz. to the gallon) for a period of 2 hours. If this is impossible they should be exposed to Cresol solution of a strength of 4 ozs. (R-W. 12) for half an hour. They should then be washed.

Books.—Unless valuable, should be destroyed. If required, they should be subjected to formalin vapour.

Topis, Pith Helmets, Felt Hats, etc.—Should be sprayed with a 5 per cent. solution of formalin.

A temperature of 104°C. injures woollen articles; if continued for 4 hours, white flannel will be turned yellowish, but the strength of the material is not affected. A temperature of 127°C for half an hour will make flannel yellow and brittle. Moderate dry heat renders flannel brittle, but if hung out on lines in the open, hygroscopic action suffices to put matters right.

Leather will withstand a temperature of 60°C. without injury.

Furs are not injured by a temperature of 80°C. for 30 minutes unless they are repeatedly subjected to it. A temperature of 78°C. will injure furs if subjected to it for 2½ hours.[3]

Steam Disinfection.

170. Definitions.—(*a*) *Low-pressure,* in connexion with disinfectors, means atmospheric pressure or zero, and not 2-15 lbs. pressure to the square inch as the engineer would understand this term.

(*b*) *Current steam* is that liberated at the above pressure and therefore at a temperature of 212°F. at sea-level.

(*c*) *Saturated steam* is steam generated under pressure and in contact with the water producing it.

(*d*) *Superheated steam* is steam under pressure raised to a still higher temperature by continued application of heat. It is of no great value as a disinfecting agent as it has feeble powers of penetration.

(*e*) *High-pressure* for disinfectors means in practice from 10-20 lbs. pressure to the square inch.

Steam at	0	lbs.	has a temperature of	212°F. or 100°C.
,,	5	,,	,, ,,	228°F. or 109°C.
,,	10	,,	,, ,,	240°F. or 115 5°C.
,,	15	,,	,, ,,	251°F. or 121·5°C.
,,	20	,,	,, ,,	260°F. or 126 5°C.
,,	40	,,	,, ,,	287°F. or 141·5°C.

171. Low-pressure steam disinfectors.—These may be fixed, mobile, or improvised.

(*a*) *Fixed.*—Two well-known fixed types are the Reck and the Thresh; examples of the latter being installed at Sialkot, Karachi, Rangoon and Maymyo.

(*b*) *Mobile.*—Of mobile types, the best known are the Thresh portable, size F (Fairy) mounted on two wheels, size G (Grouse) mounted on four wheels for use in hilly districts and the Quest type mounted on a Foden motor lorry. The first type only is used in India and constitutes the disinfecting equipment of British and Indian General Hospitals and Sanitary Sections.

(*c*) *Improvised.*—Examples are the Serbian barrel, railway disinfecting van, etc.

172. High-pressure steam disinfectors.—The majority are of a fixed type with the boiler as an integral part. The best known are :—

Jessop (boiler separate). Examples at Bombay, Karachi, etc

Bowman. (Richardson and Cruddas, Bombay.) Examples at Colaba, Wellington, etc.

Goddard, Massey and Warner.

Washington Lyon. (Manlove Alliott & Co.) Portable and fixed.

Velox.

Equifex. (Geneste-Herscher, Paris.) Examples at Bombay, Karachi, Lahore, Ambala, Deolali.

173. **Comparisons.**—Taking the Thresh portable, size F, as an example of the low-pressure and the Equifex of the high-pressure steam disinfectors, their main points may be discussed.

Thresh portable.—The temperature at which steam is generated is raised by the addition of chemicals to the water in the boiler. Though the steam is still at a temperature of 212°F., by being in contact with the jacket water at 215°F., some slight superheating may occur. The packing of clothes should be loose as current steam does not penetrate so well as saturated steam. Apart from capacity, etc., disadvantages are that the thermometer breaks easily and there is only one door which often misfits.

A rough test of disinfection is to place a potato amongst the clothes. A minimum time of 30 minutes is allowed for disinfection, and if after this time, the potato is cooked, the disinfector is being properly worked.

Equifex.—The usual pressure is 10 lbs. to the square inch, giving a temperature of about 240°F. Clothes are dried *in situ* by means of a coil of pipes in which the steam circulates. There are two doors, thus allowing disinfected clothes to be withdrawn into a "clean" room distinct from the infected room. Clothing is exposed to the steam for 15-20 minutes.

Thresh portable disinfector.

174. **Instructions for working.**—(*a*) Before introducing the articles to be disinfected, see that the water supply to the feed cistern is acting properly, and that a free current of steam passes into the machine when the steam is turned on. Also that the door to the air inlet is closed.

(*b*) Pack the articles in the cage lightly so that the steam can circulate amongst them, and do not let them touch the sides of the disinfecting chamber. Articles which would be creased if disinfected when folded, can be suspended on the hooks fitted in the machine. Not more than 30 blankets should be put in at one time.

(*c*) Having introduced the cage and closed the door, turn the steam into the disinfecting chamber and allow it to pass through for 30 minutes counting the period from the time the thermometer registers 212°F.

(*d*) Regulate the fire so that a good current of steam is maintained. Over-firing will create a little steam pressure, indicated by the liquid rising in the supply cistern. Should this occur, turn off the steam for a minute or two until the fire is damped down.

(*e*) At the end of 30 minutes turn off the steam and open the air inlet when the drying process will commence. When light articles only are being disinfected, 10 minutes drying will be sufficient, if the things are taken out and immediately shaken in the air. When mattresses, pillows and other bulky articles are being disinfected, the drying process should be continued for 30 minutes. The mattresses, etc., are then taken out and exposed freely to the air until quite cool.

(*f*) Take care that no dirt gets into the steam and air inlets to the disinfecting chamber.

(*g*) Leather goods, etc., which are injuriously affected by steam, can be submitted to dry heat in the disinfecting chamber, the process being the same as that for drying, except that the air inlet must be kept closed. The heat should be continued for 2-3 hours.

(*h*) When only one man is employed, he should wear a linen overall when manipulating the infected goods, and after introducing the cage into the machine the overall should be thrown in and disinfected. Whilst the process of disinfection is in progress the hands should be well scrubbed with soap. Care must be taken in packing and unpacking the cage to avoid risk of re-infection.

175. Instructions for cleaning.—(*a*) These machines *require to be cleaned out periodically and regularly*, the same as an ordinary boiler, so as to prevent accumulation of deposit in the bottom of the jacket.

(*b*) The solution in the jacket should be carefully drawn off into a clean vessel, such as an iron tank or large tub. Where salts are not used, the water is simply run off.

(*c*) Then the jacket should be re-charged with water, and afterwards the mudhole at the bottom of the front of single-door machines should be removed to allow the water to flush through rapidly, and a cane or scraper inserted to agitate the mud or deposit in the bottom.

(*d*) This process should be repeated once or twice, and then when the machine is clean inside, the mudholes should be refixed.

(*e*) The solution originally drawn off should be put back after it has been allowed to settle and deposit any solids, or the jacket simply re-filled with plain water up to the marked level.

(*f*) Where the water used is "hard" it is necessary to *clean the machine more frequently.*

176. **Instructions for "charging."**—(*a*) In the event of shortage of potassium salts, sodium carbonate, 8 lbs. to a gallon, can be used in place.

(*b*) The alkali can be introduced through the manhole at the top, in which case it can be put in dry. Before doing this, water should be put into the jacket to within 3 or 4 inches of the water line, which is determined by the ball valve in the feed cistern. Take care to spread the dry alkali equally.

On the other hand the alkali may be dissolved first in hot water in a large tub and introduced in liquid form into the jacket through the feed cistern. After this, admit water to within 3 or 4 inches of the water line. If filled with cold water in the first instance right up to the water line, the water will expand on boiling and overflow at the feed cistern.

(*c*) At the first time or two of working, the disinfector may "prime" a little owing to the alkali not being obtainable absolutely pure. In order to prevent this "priming" from entering the inner chamber, a soft wood-plug may be inserted into the steam inlet hole in the centre of the bottom of the inner chamber: at the same time open the air-port door in front of the machine under the large door of the disinfector itself, turn the valve handle to 'open' and keep a brisk fire going so as to maintain a steady current of steam through the air-port referred to. By so doing, any "priming" there may be, will work off through the air-port.

NOTE.—Priming occurs when water passes with steam into the inner chamber in the form of a spray.

If done once or twice thoroughly, priming will diminish and then disappear, after which the soft wood-plug should be removed to allow steam to enter, when the machine will be ready for disinfecting. Use a plug about 1 or 1½ inches thick.

(*d*) The quantity of alkali required for charging in the first instance is that amount required to raise the boiling point to about 214°F. or 215°F. at sea-level. This amount must be determined by experiment as waters vary in themselves. At varying altitudes sufficient alkali should be added to raise the boiling point 2-3 degrees about the temperature of water *boiling at that altitude.* If the temperature is found to be 4 or 5 degrees above that point, the solution is too strong in the jackets of the disinfector.

The temperature at which a correctly-charged Thresh disinfector was found to generate steam at an altitude of 6,160 feet in India was 203°F.

Note, however, that *the addition of salts* to the water in the disinfector with the object of raising its boiling point *is unnecessary.*

177. Serbian Barrel Disinfector.—An old wine-barrel is taken and in its bottom a large central hole is made, with five or six holes around it, through them the steam enters the barrel, which stands on a circular boiler of cast iron or galvanized iron. To prevent any escape of the steam between the boiler and the bottom of the barrel a narrow sausage ring, filled with sand, is placed between the boiler and the barrel. The weight of the barrel presses this down, forming an efficient valve.

To keep the clothes in the barrel away from the holes in the bottom, a small frame made of two or three crossed bars of thin wood is placed inside, over and about 9 inches above the holes. The barrel is provided with a wooden lid purposely made heavy, with an edge which fits inside the barrel or overlaps it. The object of the lid is to retard the escape of the steam.[4] Each barrel should have its own fire preferably, but if there be several barrels, they may be arranged in a row over a trench, and this has the advantage that the barrels may be embedded in a dome of dry mud, thus conserving heat and increasing efficiency. The stoke-hole would then be at one end of the trench and the chimney at the other. In devising the tank or boiler, a common error is to make too small a surface in relation to the bulk of water.

The one essential condition to success is that steam must be generated rapidly enough to fill the barrel in 40 seconds. This necessitates a vigorous fire. The time required for disinfection of clothing is one hour.[5] (See Plate 29.)

178. Railway Van Disinfector.—The principle again is disinfection by current steam. An ordinary broad or metre-gauge closed railway van is converted by the fitting of racks inside and the sealing of all but the main outlet, and steam is discharged into this in great volume from a railway engine. Such an improvised disinfector is extremely valuable on the Lines of Communication and at railheads, as, though the rate of disinfection depends upon the capacity of the van or vans which may be coupled up, it is capable of disinfecting very large numbers of kits, etc., in a much shorter time than could be done with the numbers of other disinfectors usually provided.

Cleansing and Disinfesting Stations.

179. Now that lice, fleas, and possibly other vermin have been proved to be transmitters of disease and also by reason of the actual bites cause loss of efficiency through sleeplessness, anæmia and skin infections, the use of disinfesting or "de-lousing" stations is an accepted hygienic principle.

Whilst the primary object of such a station is hygienic and to rid men and clothing of vermin and, in particular, lice, it should be borne in mind that great economy in effort can be effected if other subsidiary measures are co-ordinated. For example, whilst clothing is being subjected to scrutiny before or after disinfection, it will save further inspections by unit commanders if irreparable garments are discarded at once and a new issue be made from a main or branch clothing store attached to this unit.

The unit then becomes composite and normally will be under the charge of a selected officer or the officer commanding a Sanitary Section, the latter usually being responsible for providing the means of disinfection and superintending the laying-out of apparatus and buildings. (See section 6 (k).)

The personnel of a sanitary section should, however, not be utilized, as this impairs the efficiency of the section.

180. Objects to be aimed at.—These concern :—

(*a*) The individual—

(i) washing,

(ii) de-lousing,

(iii) hair-cutting.

(b) Clothing—

(i) de-lousing by disinfection, washing and ironing,

(ii) mending,

(iii) issue of new clothing when necessary.

181. Sphere of operation.—Such a unit operates generally on the Lines of Communication and one such unit at least should be pushed up as far as practicable with each force, so that regiments withdrawn from the field may have immediately the benefit of thorough disinfection.

It follows from this that the equipment of the unit should be as mobile as possible and simple, but there is no reason why in stations where large gatherings of troops may be expected, the arrangements made should not be of more elaborate construction.

182. Requirements of the largest stations.—The larger and less mobile disinfesting stations on the Lines of Communication will require the following accommodation:—

(i) Undressing room.

(ii) Bathroom, fitted with showers.

(iii) Officers' bathroom.

(iv) Dressing room.

(v) Soiled-clothing room.

(vi) Boiler room and Disinfectors.

(vii) Ironing room.

(viii) Storeroom for clean clothing.

(ix) Quarters for establishment.

If the personnel of a Sanitary Section or squad is employed, it will require supplementing by:—

Supervisors, British or Anglo-Indian.

Labour Corps coolies.

Dhobis, dhurzis, nais, and possibly mochis.

The problem of carrying out the objects enumerated for large bodies of troops is a very difficult one, but every effort to solve it will be well repaid in improved health and efficiency. What these problems are may be gathered when it is pointed out

that caste prejudices involve differential treatment for the Indian, and, the factor of time being so important on field service it becomes a matter of great difficulty to perform satisfactorily the several processes with the somewhat inferior apparatus which field service conditions impose. Blankets must be treated and dried in time for the men to sleep in at night; clothing must be ready for the men to march away in at a reasonable hour to allow of them getting back to their camps; underclothing must be de-loused before being handed back to the men to wash for themselves; men must wash all over before resuming their treated clothing; and men must be provided with some covering except for the few minutes allowed for actual ablution.

If disinfection of clothing only is undertaken and laundry work omitted, the procedure is simplified, but both should be aimed at.

All this can only be accomplished by most careful organization and strict adherence to time-table, always supposing the original disposition of buildings, apparatus and establishment to have been carefully planned.

The following brief outline, depicting the actual process, will assist in visualizing the requirements.

183. Planning of station.—In the first place, the station should be established close to an ample water supply and should be central. Entrance and exit should be separate and at opposite ends of the area demarcated as the site of the station. This allows of methodical admission and discharge. For the same reason the site should be surrounded with a rough fence, wall or wire, which in itself introduces order. The various buildings or shelters should be arranged so that one process leads directly to the next and finally to the exit.

The *undressing room* consists, according to circumstances, of either a demarcated piece of ground or, at the other extreme, of an elaborate shed provided with tables, cubicles or pegs. The stalls, pegs or outlined places on the tables are numbered in order from 1 upwards. In each stall, etc., are provided a black net-bag, a red net-bag, a white cloth bag and a disc with cord attached. All four are numbered with the same number as the stall. If this latter equipment is duplicated to allow of immediate preparation of the room for a second batch of men, then it will be advantageous to have the first series of discs, which are

attached to the bags, etc., enamelled white and the second series red, and so on.

Loin cloths for Indians, one to each stall, are also provided. These need not be numbered.

The Bathroom.—This leads directly out of the undressing room. Hot water is essential, 1½-2 gallons being required for each man. It promotes cleanliness much more than cold water, opens the pores of the skin thoroughly, and thus allows the thorough ingress of sulphur applications if the man is infected with scabies. The water is best provided from showers, as this method is more economical and also renders the disposal of the sullage water less of a problem. An improvised shower bath is depicted in Plate 30. Various methods of providing hot water have been tried, in Mesopotamia water was heated outside the rooms in tubs placed over litter incinerators. In France, portable heaters were employed in many places, the fuel used being coal. An adaptation of these portable heaters consuming oil fuel is more suitable for India. At least one pump is required in the equipment.

The bathroom again may either be a chittai structure divided into cubicles or a permanent shed with cubicles, showers and ground drains. Each cubicle is equipped with a basin, towel, and soap emulsion. A good emulsion is made by boiling soft soap or sunlight soap ½ lb. in 1 pint of water, adding 1 pint of non-saponified cresol and mixing for 15 minutes in a wooden tub. Then add crude petroleum until the emulsion is just not oily.

An alternate mixture is composed of soap 40 ozs ; kerosene oil 1 tin and water 1 gallon. This is diluted 1 part to 8 of water before use. Tow suffices in place of a sponge or flannel.

Soiled-clothing room.—This room leads off laterally from the undressing room and is intended to receive the soiled-clothing, which is next passed through the Thresh or other disinfector. For this reason the *boiler room* leads off this room.

Ironing room.—Best placed on the same side as the soiled-clothing room, it may either lead directly off the undressing-room or off the former. Suitable tables must be erected and apparatus for heating the irons. Ironing is employed only with serge clothing as disinfection with steam causes the cloth to perish. It is a slow process if proper attention is given to the seams (see Section 216), and therefore determines the rate of bathing. Ten to twelve minutes are occupied in the ironing

of tunic, trousers and cardigan jacket of one man. With British troops, therefore, the numbers admitted in each batch should be roughly equal to the number of ironers. With Indian troops the numbers admitted are determined by the capacity of the disinfectors for complete kits.

Dressing room.—This room should lead out of the bathroom continuing the line, and should be identical in size, shape and arrangement of cubicles, etc. A lateral door leads to the disinfectors and enables disinfected clothing to be brought into this room and laid out numerically in cubicles or spaces identical in appearance with those in the undressing room. In this way difficulties experienced with illiterate packstore havildars and in marshalling Indians are largely overcome.

An exit door leads from the building to the enclosure and thence to the open.

Storeroom for clean clothing.—In France, clothing removed from men was not returned to the same man. After disinfection the clothing was passed to washer women, washed, returned and mended before being re-placed in store. This means that underclothing had to be re-sized and was pooled amongst the men. In India this is not feasible for Indians, but may be required for British troops.

Where Army clothing stores are established, these with advantage should be located in the vicinity, so that a fresh issue may be made where articles of clothing are irreparable.

Laundry.—Where laundry arrangements are contemplated, the men either wash their own clothes or else dhobis are entertained. Some laundry arrangements are necessary for the washing of loin cloths and towels. Where the water supply is limited and river ghats are not available, the question of disposing of the sullage water has to be faced. This and the method of clarifying the sullage water for re-use is discussed in Chapter III.

Disinfecting room.—In addition to the requisite number of Thresh disinfectors, a formalin chamber is required for dealing with helmets, belts and boots. In smaller units when a Thresh disinfector is not available, cresol solution may be used. Clothes are steeped for 1 hour in a solution of 1 pint of cresol (R-W. co-efficient of 12) to 8 gallons of water, or soaked for 5 minutes in boiling soapy water. They are then washed in the ordinary way.

Buildings for the above may be made of rough cheap lumber with tar-paper and corrugated iron roofs.

184. Disinfestation process.—Men are admitted in convenient numbers, British and Indian separately. If possible, they should attend without arms; failing this, arms are stacked in the enclosure.

On entering the undressing room, each man is assigned a cubicle and informed of his number. When undressing he places, under the instructions of an attendant, his boots, belt and helmet in the black net-bag; shirts, socks, pants, drill jacket and trousers, etc., in the red net-bag; and personal possessions such as watch and money in the white bag. Serge clothing is passed into the ironing room. He then puts on the loin cloth, hangs the numbered disc around his neck, and carrying the white bag proceeds to the bathroom.

All black net-bags are collected by an attendant and are placed in the formalin-vapour disinfecting chamber.

All red net-bags are collected by another attendant and are stacked in the high or low-pressure steam disinfector and left there at 215°F. for 30 minutes in the case of the Thresh pattern.

In the bathroom, using the tow and soap emulsion provided, the man washes himself from head to foot. Occasional supervision is required for Indians. A hot shower is then given and the man dries himself with the towel provided. 3-5 minutes should be ample time. If suffering from scabies, sulphur application may be made now.

He then passes on to the dressing room where he awaits the laying out of his kit in the respective spaces. He removes the disc and loin cloth, leaves these in his stall, and dresses in his now-disinfected clothing, leaving the enclosure along with the remainder of the batch.

As hair-cutting is a part of de-lousing, those requiring it may first proceed to the *nai*, joining subsequent batches of men for the ablution process.

185. Data.—One Thresh disinfector, size F, is capable of dealing with 80 lots of shirts and pants in 20 minutes, if an ounce of formalin has been poured into the water jacket of the machine. In an 8 hour day, 1,920 men could be dealt with at this rate, but this is a high speed.

In working out the requirements for any sized unit, the following figures are useful:—

The kit of each man, *for sterilizing purposes*, may be stated in the equivalent value of thick blankets thus:—

Great coat	1
Tunic and Trousers (serge)	1
Underclothing and puttees	1
Blankets	2
TOTAL .	5

The next data are approximate only, as the number of blankets that can be disinfected in a given time depends upon the skill of attendants in loading and unloading, as well as the extent of close-packing permitted. Close-packing is to be avoided in current steam disinfectors but is of less importance in high-pressure saturated steam disinfectors on account of the greater penetration of the steam.

—	Size of Chamber.	Approximate Cubic Feet.	Loading Sterilizing Unloading.	Blankets per charge.
			Mins.	
Serbian barrel . .	65 gall.	9 6	45	7
Thresh, portable, "F" .	5′ × 3′	35 5	45	30
,, fixed . .	oval.	45·0	45	40
,, Foden. 2 chambers	6′ × 3′ 7″	120 0	45	120
Equifex H-P. . .	7′ × 3′ 6″	77 0	40	65
Bowman H-P. . .	7′ 6″ × 3′ 6″	82 5	40	70
Jessop H-P. . . .	10′ × 4′	125 5	40	105
2 Railway vans, 18′ long standard gauge.	...	...	60	450

If ironing is done, the pressure of work on the disinfectors is proportionately relieved. Though the above table is given in terms of blankets, these are not usually included in the estimate of disinfectors required, as they can be soaked in Cresol solution.

The standard aimed at is to provide a bath for each man at least once in fifteen days. Particular attention must be paid to the personnel of Labour Corps who, by reason of their long working hours, have few opportunities for self-ablution. If necessary, a half-day per week should be arranged with the proper authorities for special ablution and disinfection of this personnel.

REFERENCES.

[1] Tropical Dis. Bull. Vol. VII, No. 7, 30th June 1915, p. 408 and Vol. X, No. 6, 15th December 1917, p 330

[2] Robertson and Porter. San Law and Practice, p. 269.

[3] Nuttall. Parasitology, Vol. 10, No. 4, 1918, p. 418.

[4] Hunter. B. M. J., 24th August 1918, p. 200.

[5] Lelean. San. in War; pp. 113, 273.

CHAPTER VI.

INSECTS, ETC.

Flies.

186. Common species.—(i) *Musca nebulo*, the common house fly of India, breeds in night soil trenches, but can be reared in horse dung.

(ii) *Musca domestica determinata*, a variety of the common European species, breeds chiefly in horse dung, but also in night soil.

(iii) *Musca angustifrons*, a smaller species than the last, distinctly greyer in colour and more actively annoying, breeds primarily in human fæces, also in cow dung.

(iv) Stable fly (*Stomoxys calcitrans*) resembles the house fly except that it has a long piercing proboscis and bites. Breeds mainly in warm dung and fermenting grass.

This fly plays a totally different rôle, if any, from the 'house fly' in the transmission of disease.

(v) Green fleshfly (*Pycnosoma* species), a bronze-green fly which breeds chiefly in offal.

(vi) Grey fleshfly, resembling the house fly in colour but larger than the blow fly (*Sarcophaga* species). Breeds in offal.

(vii) Blue Bottle or Blow Fly (Genus *Calliphora*) breeds in flesh of all kinds.

The above are not all of equal importance. In practical sanitation it is the "house fly" against which, pre-eminently, measures should be directed.

187. Life History.—All these flies, with the exception of some species of the Sarcophagidæ ('Fleshflies') which are larviparous, have, broadly speaking, a somewhat similar life history. The house fly may be taken as a type Flies are now definitely proved to be capable of carrying infection but the extent to

which they are actually responsible for causing disease is not yet known.

Eggs.—A single female lays an average of 500 eggs, in batches of 150—200. They are large enough to be seen with the naked eye. Requisites for incubation are moisture, protection from direct heat and sunlight, and heat of fermentation.

Eggs and larvæ will not tolerate a temperature of 100°F., and are rapidly killed at any temperature above 114·8°F. ; the heat generated in a closely-packed heap of manure is as great as from 136—169°F. four inches beneath the surface, and advantage of this is taken as an anti-muscid measure in 'close-packing' manure dumps. (See section 81.)

The incubation period of the egg is normally 24 hours but may be as short as 8, depending on variations in temperature and humidity, for which reasons fly breeding is seasonal.

Larva.—The larval period occupies from 2—8 days. When fully grown, the larva measures 10-12 millimetres in length; it can penetrate 4 or more feet of loose earth and migrates from the breeding ground to a suitable place for pupation.

Pupa.—Though white at first, it rapidly becomes brown on exposure to light and air. Is only half the size of the larva, barrel-shape and grain-like. Pupal period usually 2—8 days.

Adult Fly.—Feeds entirely on liquid food: when attacking a solid, *e.g.*, sugar, the fly regurgitates the liquid contents of its crop on to the sugar so as to make a solution. These contents swarm with bacteria. It usually defæcates whilst feeding and also spreads infection mechanically by its feet and wings. It is the constant passage, to and fro, from latrine to kitchen that constitutes the great danger of the house fly. If food is available, flies do not travel more than a few hundred yards, but a strong wind can carry them over a mile. They may also move long distances in railway carriages, boats and with moving convoys of carts or animals. Flies at 50°F. are torpid ; between 80—90°F. they are most active, whilst a temperature of 110°F. is usually fatal but in India flies will often survive a much higher shade temperature.

Several days elapse before it reaches sexual maturity. Its total life varies from 6 days to 2 months but in cold climates, when breeding is checked, they probably pass the whole winter

hibernating as adults. The life cycle from eggs to adult may occupy from 6 days to 3 weeks.

188. **Principal breeding areas.**—Human fæces, stable litter, decaying grass heaps, in and around ill-kept incinerators, trenching grounds, refuse pits, ash bins, and litter heaps.

189. **Anti-fly measures.**—These fall under four headings, the first two having already been discussed in Chapter III.

(*a*) Prevention of fly-breeding:—

(i) In stable litter and horse dung.

(ii) In human excreta.

(*b*) Prevention of access of flies to human excreta.

(*c*) Destruction of flies.

(*d*) Protection of food.

(*c*) *Destruction of flies.*

190. **Fly-traps.**—Small fly-traps, *e.g.*, wire 'balloons,' Japanese mechanical, glass bell-traps, and many other varieties are useful for messes, canteens, cook houses, hospital wards, etc. The best baits are sugar, beer, casein, banana, fish (sardine) and meat, the last two for blow flies.

Of box-traps (see Plate 31), the very large ones, though efficient in trapping flies, have usually not been found to give results commensurate with their size and cost, unless the plague of flies is very severe. The simplest form of box-trap[1] is cubical in shape, and may be of any desired size, from one-foot cube upwards. The frame is of wood and rests upon a flat wooden platform, to which it is not attached, and from which the bottom bar of the frame is raised half an inch all round; the platform must be from 4—6 inches wider than the trap, and this outer margin must be planed smooth. The roof and lower half of the sides of the trap are covered with wire gauze; canvas is used to cover the upper half of the sides. From the bottom bar of the frame a flange of wire gauze, four inches wide, projects *inwards* all round, sloping downwards in such a way that its inner edge is ¼-inch from the platform. The trap should be baited. When flies have been caught in sufficient numbers, they may be killed by drenching with hot water, or poisoned with a spray or fumes, or the trap may be placed for a few moments in a heated oven.

For the domestic fly, wire-gauze need not be smaller than ¼-inch mesh, but it should then receive two coats of paint to round off the square interstices.

191. Tangle-foot.—To prepare:—take 8 parts of powdered resin and 5 parts of castor oil, by weight, and heat in a degshai stirring with a stick. A cheap crude castor oil, obtainable in most bazars, is quite suitable for this purpose The mixture is fluid when hot and becomes tenacious when cooled. It should not be brought to the boil. Linseed oil in the same proportion may be substituted for castor oil, but in this case the ingredients should be brought to the boil separately, thoroughly mixed, and the product, which is inferior to that obtained with castor oil, subsequently boiled for a quarter of an hour. The correct proportion of resin varies with the temperature and usually requires increasing in summer. It is immaterial whether honey or sugar be added, as experiments do not suggest that either increases the catch.

Tangle-foot is spread when hot and thin on glazed paper. Unglazed paper absorbs the oil and thus destroys the sticky properties of the mixture. It is important to cover the whole of the paper and leave no free margin. Better results are usually obtained by painting tangle-foot on lengths of hoop iron, wires (scrapped telegraph or other wire) twisted together in two strands and stretching these horizontally across huts or other shelters beneath the roof. Flies settle by day on broad surfaces and by night usually on narrow pendant surfaces, cords, wires, etc. Wires coated thus will often last for two days; they may then be cleaned by passing through a fire, re-coated and replaced.

Poison baits.

192. Sodium arsenite.—This poison is highly effective. In view of its similarity to alum it should invariably be coloured with aniline dye, preferably blue. It is issued in this form by Base and Advanced Medical Store Depots Solutions should only be made by medical officers or the trained personnel of sanitary sections. A one per cent. solution is usually employed, to which 25 per cent. gur or sugar is added subsequently.

Strips of canvas, gunny bag, frameworks of knotted string, etc, may be dipped in this solution and firmly fixed in suitable but safe places, away from messes and out of reach of animals. The poison and wet sacking, etc., should never be touched by hand.

Where hides are saved, these should be hung up and not left on the ground : they form a great attraction to flies and therefore should be hung near fly-traps, but not be treated with arsenic solution in view of future handling.

Three varieties of traps may be described :—

193. **Roller Towel Pattern Fly-trap.**—The materials required are :— A strip of sacking 15 inches wide and 8 feet long, joined at the ends to form a roller towel 4 feet long : two uprights 6 feet long, bamboo, fence or telegraph poles, etc. : two cross pieces about 2½ feet long, of packing case wood or bamboo, stakes, etc. ; a roller or cross-piece capable of rotation, with one handle : an empty kerosene tin with *one side* removed : a wind and sun screen of chattai matting or tent cloth.

The two uprights are fixed in the ground at a sufficient distance apart to allow of the insertion of the kerosene tin lying on its side. The uprights are strengthened by cross-pieces nailed or wired on. The roller is supported in loops of fencing wire attached to the top of the uprights, and is turned round by means of the handle at one end. The roll of sacking hangs from the roller, both sides outside the cross-pieces, and dips into the kerosene container, almost touching the bottom. A screen of chattai matting or canvas is erected on the windward or sunny side to prevent evaporation of the poison fluid and to afford shade and shelter to flies.

The poison mixture formula is—

Sodium arsenite (coloured) . . .	6 ozs.
Gur or sugar	24 „
Water	3 gals.

The above quantities are for each trap.

The sacking is saturated with the solution by rotating the handle. When dry, the sacking is re-soaked by rotation until completely impregnated with gur and arsenite. Water is added each morning to the container to make up for loss by evaporation. One man should be detailed (with other duties) to look after the trap and see that the sacking is kept wet. In hot and windy weather attention is required every 2—3 hours. One dose of poison will last about a fortnight except in very dusty localities. The container must be cleaned out before addition of a new dose. These traps should be located *near* latrines, garbage pits,

manure heaps, slaughter yards, etc., and *distant* from cook-houses, mess tents, wards and water supply.

194. **Karslake 'Automatic' Fly-trap.**—This is an improvement on the last. A kerosene tin is fitted at the head of the trap The roller is removed and replaced by a small trough through the bottom of which projects the sacking towel. Except for a small tube soldered into the bottom of the kerosene container, this receptacle is perfectly airtight. A screw-top filling inlet must also be fitted to this container.

When it is filled with solution, it is placed in position and the liquid discharges into the trough below, until the level of the solution in the trough meets the end of the container tube, when the air supply of the container is cut off and the solution ceases to flow.

The solution in the feed trough is now slowly absorbed by the sacking and when its level falls below the end of the tube, air enters the container again and a further supply of solution is delivered This action continues as long as any solution remains in the container.

When the container is empty, the solution, which has collected in the third tin below, is poured back again and the tin filled with water to make good loss by evaporation. This procedure will be necessary about once in every 48 hours.

If made with larger containers and a pedestal base in place of uprights sunk into the ground, it will have the advantage of being more independent of supervision and can also be moved about in relation to the fixed screens, etc. [Plate 32.]

195. **Hospital Fly-trap.**—For use in hospital wards or messes a simple apparatus can be made from a jam jar and tin lid to cover the same. The jar is filled with coloured arsenite solution, the lid pierced and a lamp wick threaded through, knotted on the outside and the ends frayed out. The lower end of the wick dips into the solution and sucks up enough liquid and poison to keep the knots moist, especially if 10 per cent. glycerine is added.[2] There is always, however, a certain danger of food being contaminated by flies that do not die, and for this reason one of the following poison baits is preferable.

196. **Formalin.**—One volume of commercial 40 per cent. formalin is added to 39 volumes of water, and treacle, honey or brown sugar mixed in. This solution may be exposed in saucers or spread on

paper or strips of cloth, or gunny bag may be soaked in it and hung up in latrines, etc. The strength of the solution is important to success.[3]

197. Sodium salicylate.—Add three teaspoonfuls of powdered sodium salicylate to a pint of water. Nearly fill a glass tumbler or other receptacle with the solution, place over this a piece of blotting paper cut to circular form and somewhat larger in diameter than the tumbler, and over this invert a saucer. Invert the whole device and insert a match under the edge of the tumbler to allow access of air. The blotting paper will remain moist until the entire contents of the tumbler have been used. A little sugar sprinkled on the paper increases the attractiveness of the poison for flies.

Either Formalin or Sodium salicylate solutions can be used in this manner ; the former has an unpleasant taste and the latter even in comparatively large doses is harmless, hence the dangers of accidental poisoning are small.[3]

198. Fly-Sprays.—Three types of sprayers are commonly used :—

(i) Heppel's.
(ii) Mackenzie's.
(iii) Holder Harriden's.

The last is considered the best. Spraying fluids which are recommended are :—

(i) Army Fly Spray, the composition of which is secret. This is diluted 1 in 15 with water before use.
(ii) Admiralty fuel (oil) to which Kerosene has been added in 15 per cent. strength. The whole is diluted for use with one quarter kerosene.
(iii) Crude Kerosene, flash point 125 degrees, or Kalyan oil.

Spraying is effective only upon flies when congregated together in clusters at evening or early morning on the roof, walls, wires, ropes, etc., or during the day on waste food or in sunny spots. The spray should be directed as a cloud above the clusters of flies until they fall, but should cease as soon as the surface sprayed shows signs of wetting.[4]

Spraying machines should be cleaned and kept in order according to the instructions issued by the makers.

199. Fly-Flaps.—The best are those made of wire mesh. If leather flaps are used, they are more efficient if well perforated.

(d) *Protection of food.*

200. Accessory measures.—As the contamination of food by flies is the principal danger of these pests, it is well to remember that *there is no such thing as a fly-proof kitchen* and so all food should be stored in fly-proof safes (see Plate 28, Figs. 1 and 2), or covered with mul-mul cloth. It is more important to place in food-safes food which is not cooked, such as bread, biscuits, cheese, jam, sugar, etc., and it is also advisable to provide similar receptacles for eating and drinking utensils.

201. Guide to requirements.—The following scales are given to serve as a rough guide to requirements in anti-fly apparatus and chemicals; obviously the quantities will vary with the size of the fly epidemic.—

Army Fly-spray . . .	¼ pint per Mackenzie or Holder Harriden Fly-spray per diem, rising to ½ pint and 1 pint during the worst months.
Kerosene oil . . .	½ gallon per diem for the above sprays, rising to one gallon during the worst months.
Formalin . . .	4 fluid ounces per week per unit.
Arsenite of Soda . .	6 ounces per trap during the worst months.
Gur or Sugar . . .	24 ounces per trap during the worst month.
Tangle-foot Fly-paper .	One box per unit as supplied by the Supply and Transport Corps.
Fly-flaps . . .	2 per tent or as required.
Fly-traps . . .	As required. Usually manufactured by the Engineer Field Parks.
Mul-mul cloth . . .	5 yards per 100 men.
Fly-proof Food-safes . .	1 per B. Os'. Mess, 1 per N. C. Os'. mess and 1 per British cook house, manufactured usually by the Engineer Field Park.
Hand fans . . .	As required.

Summary.

202. The following brief points should be borne in mind :—

(i) Attacks on the adult fly are not likely to produce appreciable effects on the numbers of succeeding generations.

(ii) Eggs and larvæ should be destroyed in the breeding places.

(iii) Watery emulsions or solutions of larvicides lose their efficiency in the presence of water.

(iv) Larvicides of an oily nature retain their potency for long periods and are therefore the most suitable agents to employ.

By far the most important measure for combating a fly plague is to abolish breeding grounds. They can *always* be found. Attacks on the adult fly are of very secondary importance.

203. Memorandum to troops.—The following notes may be of use in drawing up a memorandum.

Fly reduction.

(i) Whenever possible, trench latrines should be abolished in favour of the tin and incinerator system. So long as the shallow trench latrine system is in use in any part of a camp, flies are bound to swarm.

(ii) Where trench latrines must be used, fly-breeding must be prevented by the liberal use of light mineral oil or some other agent that will prevent flies settling and maggots developing.

(iii) A bottle of this oil should be at every trench ; each man using the latrine should sprinkle oil and then earth ; when the trench is filled in, earth and oil should be used.

(iv) If this is done, flies will not settle on the fæces, they will not lay eggs, and the fæces will be surrounded by a layer in which maggots cannot live.

(v) It should be noted that fuel-oil, pesterine and the like will not do for this purpose ; the volatile constituent must be present.

(vi) Even where tins are used, oil should be sprinkled to keep flies off the fæces.

(vii) Unless it is certain that the heaps will burn and are burnt completely, it would be better to spread out wet horse dung till it is dry, then put it in heaps to burn. Dry horse dung breeds no flies but wet horse dung preserved from dessication in litter sweepings, etc., does.

(viii) The proper disposal of kitchen refuse is important. Where incineration cannot be practised and it must be buried, it can be oiled. Above all it must be collected; chance bits of wet refuse thrown on the ground, not noticed, breed both house flies and blow flies. A danger source is the offal of goats slaughtered by Indian units. It should be incinerated and, failing that, buried at once before flies can lay eggs on it.

(ix) Where possible, as in standing camps, there should be a supply of oil at the butchery, and when the pit is being filled in, oil should be poured over at about 12 inches from the ground level, to form a protective covering through which maggots or flies cannot come to the surface.

As every one suffers alike from a plague of flies, all ranks must understand that dirt and carelessness breed flies. The man who defæcates in a ditch, the man who throws down food refuse anywhere, the sais who does not burn his horse dung; these help to produce the plague; flies always mean a faulty latrine system or a dirty camp. There is a belief that flies breed all over the place, in the desert, in soil, etc So far as house flies and blow flies go, this is not so; man himself produces his own plague of flies.

Mosquitoes.

204. The following diseases are transmitted by mosquitoes:—malaria, dengue fever, yellow fever and filariasis.

205. Rough differentiation between Anophelinæ and Culicinæ:—

ANOPHELINÆ.	CULICINÆ.
Egg.	
Boat-shaped, having dorso-lateral floats transversely or radially striated and a median band of secretionary matter.	No markings as in Anophelinae. Micropilar spinous process at head end.

ANOPHELINÆ.	CULICINÆ.

Egg

Aggregation into clumps occurs, giving triangular and star shapes.	Aggregation occurs into rafts of hundreds of eggs. Raft sags in middle. Each egg lies vertically with head downwards.

Larva.

No siphon-tube but only apertures on 8th abdominal segment.	Long or short siphon-tube on 8th abdominal segment.
Floats parallel to surface of water.	Floats head down with siphon-tube on surface.

Nymph.

(Breathes air through spiracles placed at cephalic end.)

Short stumpy funnel-shaped spiracles.	Spiracles longer, more slender and trumpet-shaped.

Imago.

Antennæ :—

Male, plumose (feathery).

Female, pilose (hairy).

Appears to stand on its head when resting (*exceptions*).	Rests parallel to the surface.
Palpi. Long and clavate (club-shaped) in male. Long and thin in female.	Palpi. Long and acuminate (tapering) in male. Short in female.
Wings. Generally spotted .	Wings. Generally plain.
Proboscis. Usually in line with body.	Proboscis. Usually bent at angle with body.
Breeds in rivers, lakes, streams, pools, ponds and all collections of waters but each species has a selective breeding ground for preference; *e.g.*, *A. stephensi Liston* is pre-eminently the well-breeder of India. (*Many exceptions.*)	Breeds in tubs, ditches, garden cisterns, gutters, tins, fire buckets and drains for preference. (*Many exceptions.*)

206. **Adult mosquito.**—The length of life is uncertain; in captivity 2—3 months. In the hot weather it is capable of remaining in houses from March to June, during which period it does not lay eggs. Under suitable conditions larvæ become pupæ in about one week. The female alone sucks blood.

The distance of flight is not definitely settled; for practical purposes a radius of one mile may be taken to be the outside limit. (For Preventive measures, see under Malaria, Chapter VII, section 334.)

Sandflies.

(Family Psychodidæ; Genus *Phlebotomus.*)

207. **Phlebotomus papatasii** conveys the infection of pappataci or 'sandfly' fever.

208. **Life History.**—The following is the general life history of the various species of the Pappataci Fly as far as is known:—

Eggs.—Eggs are laid singly or in small clusters and number from 30—80 in different species. They hatch in from 6—9 days and are found in damp refuse, cracks and fissures in soil, mud walls and irrigation culverts, and probably always the presence of rotting organic matter is essential.

Larva.—The larva is cylindrical and like a small caterpillar. It is studded over with spines of minute size and lives in mud or wet earth (but not water) for variable periods from 2—14 days.

Pupa.—The pupa selects a dry spot and matures some 6—10 days later. The whole period from egg to adult probably covers one month in hot weather and two in cold weather.

Imago.—The female alone sucks blood. The body is slender, measuring 1½—2 millimetres; legs, antennæ and palps are long; the proboscis prominent, projecting vertically beneath the head. The body colour is yellowish-brown. When disturbed, it flies characteristically in short jerks to left or right as if hopping like a flea. The range of flight is relatively short, probably not more than 50 yards. It bites principally at night. About half a dozen species are known in India.

On the North-West Frontier they are most numerous during the latter part of April and the month of May: they diminish in

numbers in June and July, become numerous again in August and lessen gradually in September and October, disappearing entirely with the latter month.[6]

Preventive measures.

209. **Sanitation.**—Few special measures can be directed against breeding grounds as these are numerous in character and extremely difficult to detect. The cause of dampness in barrack walls should be determined and, if possible, eliminated. A liberal application of whitewash to cracked mud walls of huts that are occupied, may assist in keeping down this pest, if not, evacuation may be necessary. Useless delapidated walls should be razed level.

210. **Nets.**—Mosquito nets of mesh 14—18 strands to the inch are useless. A mesh of 24 strands is the minimum to be of value, but nets of this mesh, or muslin, are unbearably stuffy as they allow little or no ventilation.

211. **Repellents.**—Citronella oil in vaseline, oil of bergamol in kerosene, 50 per cent. alcoholic solution of thymol, oil of cloves in lanolin, oil of cassia, oil of eucalyptus, camphor, vermijelli, have all been recommended. (See section 340.)

The sandfly is a weak flyer and a good punkah or fan is an excellent preventive against bites.

(*N.B.*—A brightly burning kerosene lamp, even more than a human being, attracts sandflies into a tent or building.)

212. **Fumigant Insecticides.**—For barracks and buildings:—phenol and camphor, equal parts, 4 ounces of each to every 1,000 cubic feet of air space. (See section 337.) Sulphur dioxide gas is also useful.

Lice.

213. Typhus, Relapsing fever and possibly Trench fever are transmitted by lice. They also give rise to great cutaneous irritation. There are three varieties :—

(i) Pubic louse (*Phthirus pubis*).

(ii) Head louse (*Pediculus humanus* (*capitis*).)

(iii) Body louse (*Pediculus humanus* (*corporis*).)

214. **Pubic louse.**—Rare. May infest axillæ and eyebrows also Causes much irritation and often latter gives rise to extensive

inflammation. Unguentum Hydrarg. flav. 2 per cent. is useful for extra-pubic infestation, otherwise any of the remedies for the body louse may be tried.

215. Head louse.—The eggs or 'nits' are minute yellowish bodies and are seen adherent to the hairs. Adult lice are best found by combing with a fine tooth comb.

Frequent washing with carbolic soap or cresol soap and the wearing of the hair short prevent infestation.

Close cropping and treatment with 10 per cent. acetic acid; 4 per cent. formalin solution; paraffin; petrol; soap liniment; white precipitate ointment or 5 per cent. oleate of mercury in ether, with subsequent thorough washing, will cure.

Tar oil emulsion or a 5 per cent. solution of crude carbolic soft soap emulsion may be tried. Each is more effective than paraffin and cheaper than sassafras oil.

216. Body louse.—The eggs take 7-10 days to hatch under normal conditions; *i.e.*, in clothing which is constantly worn. In discarded clothing the time for hatching may extend to 5 weeks. During this period there are three moults.

Active lice can exist under favourable conditions without food and apart from any host for periods up to 9 days. Young lice take 10—14 days to attain maturity, and require 2—4 days before they commence to deposit eggs. Food and temperature control egg-laying, 75°F. being the optimum temperature. Without food or under cool conditions (below 65°F.) females do not lay eggs. Eggs laid by unpaired females do not hatch nor do eggs laid after 20 days from impregnation of the female. Each female lays 10-12 eggs daily over a period of 10 days, but as many as 300 eggs may be laid by one female. The female after maturity may live for 46 days and before the end of her life may have 4,160 descendants.[7]

In clothes the eggs are laid among and are attached by a cement to the fibres of clothes. The female exhibits special predeliction for seams and linings—a point of importance. The adults migrate from their host and thus spread infestation and possibly infection. Tiny punctures of the skin, with inflammation around, indicate infestation, whilst the eggs should be looked for in seams.[8]

Preventive measures.

217. Trial has been made with shirts dipped in Cresol solution and afterwards dried, but the percentage cresol necessary for complete prevention leads to irritation of the skin.

Garments dipped in a benzol solution of naphthaline and sulphur, 1 per cent. of each, become impregnated with the last two chemicals on the evaporation of the benzol. They cause no irritation when worn next to the skin and retain their preventive effect for an appreciable time.[9]

Naphthaline alone, used to impregnate underclothing in proportion of 2 milligrammes to 1 square centimetre, loses its lethal effect in 5 hours.

218. Vermijelli.—A jelly of crude mineral oil 9 parts, soft soap 5 parts and 1 part water. As prepared by the manufacturers the product is refined. A less-refined form can be made as follows:—Heat 3 lbs. of soft soap, carefully adding half a pint of water. When hot, remove from the fire and stir in 5½ pints of crude mineral oil and stir vigorously. The whole forms a jelly on cooling which is perfectly miscible with water.[10]

One ounce per man forms a weekly issue and is smeared on seams of clothing in conjunction with N. C. I. powder. This combination asphyxiates the young as they hatch.

219. N. C. I. Powder.—A mixture of Naphthaline 96 per cent. Creosote 2 per cent. and Iodoform 2 per cent. One ounce per man is sufficient as a weekly issue and is dusted on the outside of the shirt or vest Crude unwhizzed Naphthaline powder is as effective as N C. I. powder and cheaper It is most effective if men dust their clothes freely and roll themselves and their clothing tightly in blankets for the night.[11] Insecticides which act by vapour have, however, a restricted range, at the outside 2 inches. Used as powders they are wasteful as they soon dust out of the clothing. Crude naphthaline is cheaper and more effective than pure.

Keating's powder (Pyrethrum); petrol or kerosene; vaseline and camphorated oil 10 per cent, have also been recommended. Sassafras and other essential oils are effective, but kill by contact and not by vapour under conditions of use.

Destruction in clothing.

220. Lice, with their eggs, may be destroyed by :—

(i) *Loose* packing in a Thresh or current steam disinfector and exposure for at least half an hour to a temperature of 131°F. (*N.B.*—The Thresh disinfector generates 215°F.) Eggs when killed lose their shiny appearance. Barrel disinfectors suffice where only a few clothes are treated. In the destruction of lice by heat the all-important factor is penetration.

(ii) Hot-ironing, especially of seams, or subjection to a jet of steam from a boiler or kettle.

(iii) Immersion for 1 hour in 1½ per cent. cold cresol solution or for 24 hours in 7 per cent. cold solution of Bleaching powder, but the use of the latter should be limited to articles of clothing, salvage material, etc., in which a bleaching effect is immaterial. Valueless clothing should be burnt.

Immersion for 5 minutes in a 5 per cent. solution of crude Carbolic soft-soap emulsion, or 5 per cent. Tar-oil soft-soap emulsion, or a 10 per cent. watery solution of Sassafras oil kills both eggs and nits. Sassafras oil solution is made by melting one part of soft soap in 5 parts of water by heat and adding 20 parts of Sassafras oil very gradually, at the same time shaking or stirring thoroughly.

(iv) Petrol, paraffin, benzine or 10 per cent. formalin used as a spray, or immersion in boiling water for 5 minutes, are also effective, but not all the nits are killed by paraffin. Vermijelli can be used in place of soap for washing clothes.

Destruction in buildings.

221. The ordinary methods of fumigation effect this but results depend on a sufficient concentration and even distribution of the gas. For this reason it is better to use 6 lbs. of Sulphur to every 1,000 cubic feet of air space.

If the Clayton apparatus is used, 8 per cent. of gas for ½ hour or 5 per cent. for 2 hours should be the minimum treatment.[12]

222. Memorandum to troops.—The following memorandum is suitable for insertion in Regimental Orders, when the necessity arises:—

Measures against lice.

(i) If you will only take the trouble it is possible to keep yourself reasonably free from lice, and the discomfort and irritation which they cause.

(ii) Search your clothing, particularly trousers, shirt and undershirt, as often as possible, examining all the seams and destroying the lice as found.

(iii) Look carefully for eggs, small pearly oval bodies attached to clothes along the seams, and destroy them by running a lighted match, a tinder lighter, or a hot wire along the seams.

(iv) Use the ointment and powder (Vermijelli and N. C. I. power) provided, mixing the two together. Rub into the seams of your clothes. At the fork of the trousers it should be placed under the fold of cloth, so as to prevent direct contact with the skin Do this every four days.

(v) Remember that you become infected from a verminous man and not from the floor of a hut, tent or other billet. If you know that a particular man is not taking the trouble to clean himself and is infecting yourself and comrades, report the matter to your Commanding Officer.

(vi) Remember that lice, apart from the irritation caused by their bites, are *carriers of two dangerous diseases—Typhus and Relapsing Fever*, and that a 'lousy' man runs the risk of contracting these diseases and spreading them among his fellows.

(vii) Take advantage of all opportunities of bathing and disinfection in addition to that provided.

The bed bug.

223. Diseases transmitted.—None are known definitely but the bed bug has been suspected of causing Kala Azar, Leprosy, Tubercle, Plague, Anthrax, Relapsing fever and Typhus.

224. Bionomics.—There are two species:—*Cimex lectularius* in northern climates and *Cimex rotundatus* in the tropics. The female lays batches of 20 eggs at a time and throughout the year,

The eggs hatch to larvæ in 4—8 days and, passing through larval and nymphal stages, reach the adult stage in 6—7 weeks in hot weather and 9—11 weeks in cold weather.

In Madras a *Cimex rotundatus* was kept alive for 4 months without food but under natural conditions it feeds every day or two. Both the male and female bite and take about 4 minutes to become replete—even then they will return to feed when apparently engorged. Egg-laying commences in 10—14 days after the adult stage is reached. Bed bugs have been known to travel 50 yards for a feed, hence the radius for destruction of these pests is very great.[13]

Preventive measures.

225. The legs of charpoys, bedsteads, etc., may be put in tins containing kerosene to prevent invasion from the floor. Camphor or naphthaline sprinkled amongst the bed clothes are weak and somewhat inefficient repellents.

A method employed with some success in buildings to prevent the return to the roof of bed bugs which have descended for feeding purposes, is to render a strip of wall 12 inches in width and 3 feet from the ground perfectly smooth and shining. This is done by tarring the wall. Bed Bugs that descend to feed cannot re-cross this barrier and then are within range on the floor of whatever cimicide is used.

Destruction of bed bugs.

226. Bug-traps.—The ordinary Indian bug-trap consists of a piece of wood roughly 6 inches long, 4 inches wide and 2 inches thick. A dozen holes are bored in this and the trap is set in the bed. Bugs are shaken out in the morning and may be burnt.[14]

Another trap consists simply of a piece of corrugated card-board such as is used for packing bottles. The bed bugs creep inside the two layers of the card.[15]

Such palliative measures can scarcely be recommended.

227. There is no really satisfactory method of ridding an infested room. Beds or ironwork can be freed of eggs by the painter's blow lamp played on the surface rapidly. Fumigation, which does not kill the eggs and which is only possible in buildings that can be hermetically sealed, may be carried out with —

(i) Sulphur dioxide gas, 2 lbs. of sulphur per 1,000 cubic feet.

(ii) Camphor and Phenol, 4 ounces of each per 1,000 cubic feet. (See Section 337.)
(iii) Hydrocyanic acid gas. This requires an expert and is somewhat dangerous but very effective. [See Section 167.]

Local applications to furniture, etc., claimed as effective, are acetic acid, coconut oil, kerosene as a spray, carbolic acid, perchloride of mercury, and turpentine. Army Fly Spray, diluted 1 part in 10 with water, is said to be efficacious. Charpoys can be freed from bugs, lice, etc, by inverting and dipping in a shallow tank containing boiling water.

Fleas.

228. Fleas transmit plague. There are two different generic species which commonly attack man.—*Pulex irritans* the human flea and *Xenopsylla cheopis* the rat flea. The latter deserves consideration from the rôle it plays in the transmission of plague.

229. Life History.—The female lays large eggs singly; these hatch in from 2—4 days. The eggs are simply deposited on the ground or bedding The larval form occupies 10 days or longer in cold weather. It is a maggot-like creature and moves actively in dust, sand or debris. The pupal stage occupies another 7—10 days normally, but the whole cycle from egg to adult may in cold weather extend to 5 weeks.[16]

230. Role in Plague.—The plague bacillus, *B. pestis,* is conveyed from rat to rat and rat to man by *Xenopsylla cheopis* and sometimes by *Ceratophyllus fasciatus* Both the brown sewer rat, *Mus* (*Epimys*) *norgevicus*, and the black rat, *M. rattus*, suffer from plague. The latter is more dangerous from its closer association with man. When rats become ill or die, the fleas leave them and attack man.

Bacillus pestis multiplies in the flea so that when the latter defæcates which it frequently does when feeding, thousands of plague bacilli are deposited near the puncture wound made by the flea. The infected fæces are rubbed into the wound by the human host when scratching the site of the bite.

Bacot and Martin have shown, however, that while infection may take place as the result of the fæces being rubbed in at the time of feeding, yet the ordinary way is probably by bacilli regurgitated from the oesophagus of the flea—(See Section 353.)

Preventive measures.

231. Eliminate all dust and fine organic debris from flea-infested buildings. Where possible, remove textile floor coverings and sprinkle naphthaline, pyrethrum, or Keating's powder which must be fresh and dry. Pesterine and tri-cresol powder are also good preventives Saponified Pesterine is composed of kerosene 20 parts, soft soap 1 part and water 5 parts. Tri-cresol powder is 3 per cent. cresol powder.[17] A solution of naphthaline in benzine may be poured into rat holes, etc.

232. Fumigation, etc.—Infested houses should be fumigated with sulphur 4 lbs. per 1,000 cubic feet airspace, or with formaldehyde vapour, produced by adding 20 c.c. of formalin to 8 grains of powdered potassium permanganate. This will kill adults and all other stages of the flea. Hydrocyanic acid gas fumigation is coming more into use Huts made with mud walls and floors may be freed from fleas by burning a six-inch layer of straw on the floor.

The Itch Mite.

(Sarcoptes scabei.)

233. Life History.—The female is the cause of most of the discomfort caused by this pest. It burrows under the epidermis and lays 24—48 eggs It lives for 2—3 months. The eggs hatch in about 7 days to 6-legged larvæ which, after one moult, become 8-legged nymphs and the latter after two moults become sexually-mature males and females. After pairing, the males die and the females cast their skins, become oviparous and start their subcutaneous life. Mites can live for 10 days away from a host, provided the air is warm and moist.

Prophylaxis.

234. To prevent the spread of scabies the following measures are important[18] .—

(i) Weekly inspection of all men, patients, staffs of hospitals, depots, etc , men going on or returning from leave, and newly joined recruits. The inspection must be made in a good light.

(ii) Blankets before re-issue to another unit or return to store must be disinfested, and those issued to the soldier should

body, special attention being paid to the parts where infestation is commonest. To prevent cross infection, the soap should be in a special container and a clean spatula used, whilst brushes after use should be dipped in boiling water.

(v) Debris and soap are now rinsed off either with a warm shower or in the original bath water. A clean towel is used for drying.

Parasiticidal treatment.—Under the following treatment and with careful attention to detail, a soldier suffering from an uncomplicated attack of scabies should not be ineffective for more than 3 days.

The most suitable parasiticide is *Liquor Calcis sulphuratæ* (B. P. Codex formula). 3-5 ozs are placed in a clean saucer for each patient. An orderly wearing rubber gloves dips a 6 inch square of clean lint in the liquid and rubs this all over the body. The liquid must not be allowed to run on to the glans penis, and should be allowed to dry in, no towel being used. If an enamelled iron vessel be used, it must have no exposed metal Lint after use must be destroyed. The stock bottle of the solution should not be larger than 20 ozs , and must never be left with the stopper out. If the patient's skin is very sensitive, at the first application the fluid may be diluted one half with hot water. After treatment, the skin is yellow and inspection will determine whether the application has been thorough.

The bath and treatment are repeated in all details next day. Two thorough applications of the undiluted liquor on successive days are usually sufficient to destroy the parasites. A third application, rarely necessary, should be avoided if possible, as it may cause dermatitis.

237. A less satisfactory alternative to the above treatment, is the use of Unguentum sulphuris, 1 in 15 and not 1 in 10, which is the B. P. ointment. Not more than 2 ozs. are used at a time. 20 minutes rubbing ensures thorough absorption and the treatment is administered in all details on the 2nd and 3rd days.

Ticks.

(Ixodoidea.)

238. So far as is known, ticks do not convey disease in India. In Africa, however, a tick (*Ornithodorus moubata*) is the intermediate

host of *Spiroschaudinnia duttoni*, which gives rise to African Tick fever; in America, Spotted Fever of the Rocky Mountains is conveyed by another tick, *Dermacentor andersoni*. Coming nearer to the borders of India, in Persia a tick of the Genus *Ornithodorus* is credited[19] with transmitting Relapsing fever whilst another tick, *Argas persicus* or 'miana' bug locally known as '*Guerib-guez*,' infests man and gives rise to a spirochætal disease (*S. gallinarum*) in fowls, ducks, geese, etc. The bite of the latter tick is said to be very painful and produces sometimes severe pain, fever, lassitude, delirium, convulsions and, at times, even death in new-comers. Whilst some consider these symptoms are due to the injection of a poison, it seems more probable that they are those of a definite parasitic disease introduced by the tick.[20]

239. Bionomics.—Eggs are laid on the ground usually; in the Family Argasidæ they are also laid in walls, etc, and in several batches, each numbering from 40—200 These hatch into 6-legged larvæ usually brown in colour and about the size of small pin heads. They infest grass, being known as 'grass-lice,' and attach themselves to any host and after a meal and a moult become 8-legged nymphs The latter after a variable number of meals and moults become sexually-mature adults. A feature of the adult is the powerful rostrum or proboscis which projects from the head, the mandible of which is provided with barbed teeth. These teeth, either in the larval or adult stage, render the extraction of a tick from the skin a difficult procedure. An important point is that the female transmits spirochætes to its ova, so that the next or future generations may also be infective.

240. Treatment.—To remove a tick from the skin, force should not be used, otherwise either the surrounding skin is torn or, as is more probable, the head of the tick is ruptured and the rostrum remains buried in the skin. On the contrary, ammonia, turpentine, kerosene, benzine, petrol, paraffin or carbolized vaseline should be applied between the skin and the under surface of the tick. Any oil smeared on the ventral surface of the tick interferes with its respiration and causes it to drop off.

Bites should then be bathed with very hot water and subsequent irritation may be allayed by Menthol ointment. A retained rostrum should be moved with needle forceps after cocainization.

Preventive measures.

241. Badly infected native huts should be burnt and troops should not be located near infested habitations. Ordinary quarters can be freed by fumigation or spraying with kerosene. Charpoys, etc., must be raised from the ground and their legs placed in tins containing kerosene.

242. Where ticks are suspected of giving rise to relapsing fever, an important preventive measure is the actual treatment of the sick by salvarsan, whereby the reservoir of future infection is destroyed.

243. With regard to *Argas persi us*, as this is a parasite of the domestic fowl and other birds, and as it takes many weeks for the tick to reach maturity, much may be effected by attention to these animals. Older fowls should be disinfected with a kerosene emulsion or oil of sassafras and younger fowls isolated in cages until the ticks drop off. Fowl houses require cleansing and treatment with lime and corrosive sublimate; old nests and roosts should be burnt and new fowl houses kept sprayed with kerosene emulsion.[21]

Ants.

244. Ants have been incriminated experimentally in the spread of typhoid and cholera. Thus in times of cholera epidemics, they should be kept away from foodstuffs. Legs of tables, etc., may be placed in tins containing kerosene oil Keating's or other insect powders sprinkled on the floors of tents tend to keep out these insects. Where white ants are prevalent, tent pegs, table or trestle legs may be tarred.

REFERENCES.

[1] Lelean; Sanitation in War, page 154.

[2] Lelean; Sanitation in War, page 157.

[3] D. M. S. in India No. 19005-1 (D.M.S.-5), dated 12th April 1917.

[4] The Life History of the Fly, G. H Q Mes. Expdy Force, March 1917

[5] Journal of Hygiene, Vol. 16, page 124.

[6] R. A. M. C., Journal, Vol. 19, page 450; Robinson and Blackham.

[7] Bacot; Lancet, 17th March 1917, page 421.
[8] Mem. on some Med. Dis. in the Med. War Area, page 51.
[9] Gunn, British Medical Journal, 5th May 1917, page 579.
[10] Lefroy's pamphlet 'Measures for avoidance, etc.', page 14.
[11] Lelean, Sanitation in War, page 162.
[12] Mem. on some Med. Dis. in the Med. War Area, page 126.
[13] Patton and Cragg; Text book of Medical Entomology, page 508.
[14] Patton and Cragg; Text book of Medical Entomology, page 507.
[15] Lefroy's pamphlet 'Measures for avoidance, etc.', page 13.
[16] Patton and Cragg; 'Medical Entomology', pages 458 *et seq.*
[17] Mem. of some Med. Dis in the Med. War Area, pages 55, 107.
[18] D. M. S. No. 6638-2 (D. M S -5), dated 1st February 1919.
[19] Stitt; Tropical Diseases, page 80
[20] Castellani and Chalmers; Man of Trop. Medicine, page 191.
[21] Castellani and Chalmers; Man. of Trop Medicine, page 950.

CHAPTER VII.

SOME IMPORTANT DISEASES.

Beri-Beri.

245. Beri-beri is classified as one of a group of diseases lately described as food deficiency diseases. Other members of the group are Scurvy, Pellagra, Sprue and Rickets. Conditions regarded as being *varieties* of Beri-beri are :—Ship beri-beri, infantile beri-beri, epidemic dropsy, and oedema disease; whilst different *types* of the disease are :—wet or dropsical beri-beri, dry or atrophic beri-beri, acute pernicious beri-beri, and paraplegic and rudimentary types.

Synonyms of beri-beri are :—Neuritis multiplex endemica, Polyneuritis endemica, Hydrops asthmaticus, and in Japan Kakke.

The disease is characterized by symptoms of polyneuritis, cardiac degeneration and general prostration.

246. Aetiology—There have been numerous theories as to the causation of beri-beri. Most of these have been disproved; of the others, the following may be mentioned :—

(i) *Nitrogen starvation.*—Takaki claimed to have eradicated beri-beri in the Japanese Navy by increasing the nitrogen content of the diet. It should be noted, however, that he increased also the vitamine content.

(ii) *Deficient Phosphorus.*—This is now known to indicate a deficiency of vitamine. The quantity of phosphorus runs parallel to the vitamine content and forms a useful guide. Calculated as P_2O_5, the phosphorus content of rice, wheat, and other grains should not fall below 0·4 per cent.

(iii) *Infected or decayed food*—This theory has been revived recently by Lebredo, who claims to have grown a spore-

bearing organism from the amylaceous elements of the rice eaten in a recent epidemic. The spores resisted 100°C for 20 minutes and grew well only in boiled rice. The germ exists naturally in rice but the pericarpal pellicle serves as an excellent protector.

(iv) *The Vitamine Theory.*—This is the theory which now holds the field and it may be taken to include some, if not all, of the essential facts in the causation of these food deficiency diseases. It has now been proved for several years that in addition to the usually recognized constituents of a diet, *i.e.*, protein, fats, carbo-hydrates, salts and water, the food must contain what were at first called accessory food substances and now have been all included in the term *vitamines*. In their continued absence vitality is lost and eventually death occurs.

It should be borne in mind that, so far, the chemical and biological nature of vitamines have not been proved except by experiments under artificial conditions upon animals whose metabolic processes are not necessarily similar to those in man. For practical purposes it may be accepted that, although there are probably a number of these vitamines, two groups, of interest from the military point of view, exist, *i.e.*, anti-beri-beri and anti-scorbutic. Recent work seems to show that anti-beri-beri vitamine itself contains at least two factors—one anti-neuritic concerned in the nutrition of nerves, and another concerned in the process of growth.

Various foods contain these substances in different degrees and from some they are practically absent. When a diet is provided in which the anti-beri-beri vitamines are insufficient, beri-beri gradually appears This has occurred most commonly in rice-eating people, for the reason that such people frequently live almost entirely on rice, and then, if the particular rice is deficient in vitamine, the disease will occur. In Europeans, under ordinary conditions, the diet is so varied that deficiency can rarely occur and beri-beri is almost unknown. But it must be remembered that any diet, whether of rice or any other food, if it is deficient in vitamines, will produce a food deficiency disease. It is therefore essential to know the vitamine values of various foods and a table of those which are known is here given

Value of Foodstuffs as preventive against Scurvy and Beri-beri.[2]

Foodstuffs.	Value against Beri-beri.	Value against Scurvy.
CEREALS—		
Whole grain, wheat	+ +	0
Endosperm, polished rice	0	0
,, white flour (wheat)		
Bran, *e.g.*, rice	+ +	0
,, ,, wheat		
Germ or embryo, *e.g.*, rice	+ + +	0
,, ,, wheat		
PULSES—		
Whole, in dry condition	+ +	0
GERMINATED PULSES (or Cereals)	+ +	+ + +
VEGETABLES—		
Potatoes	0	+ +
Fresh, *e.g.*, cabbage		
,, onions	±	+ +
,, carrot		
Desiccated vegetables	+	+ to 0 according to age.
Pickled, *e.g.*, cabbage	*	0
FRUIT JUICE—		
Fresh, *e.g.*, orange	*	+ + +
,, lemon		
EGGS—		
Fresh	+ +	*
Desiccated	+ +	0
MEAT—		
Fresh	+	+
Tinned	0	0
MILK—		
Cow's, fresh	0	+(slight)
YEAST—		
Pressed, autolysed	+ + +	
Extract, commercial sample A.	+ + +	

Signifies not investigated.

It has been found that in grain foods the vitamine is contained almost entirely in the germ or embryo and therefore rice-eaters, who are supplied with highly polished white rice, suffer much from the disease. The aleurone layer, apart from the germ, is not so important.

247. Resistance of Vitamines to Heat.—The vitamines are fairly resistant; the anti-beri-beri withstands drying and also a temperature of 100°C for 2 hours. At 120°C it is soon destroyed. Anti-scorbutic vitamine is destroyed by drying, but withstands 100°C for ½ hour.

248. Sources of Vitamines.—One of the most fruitful sources of anti-beri-beri and anti-scorbutic vitamines is from the germination of pulses and cereals (See Section 382). Another similar source is the proprietary article 'Marmite' which is often supplied as a ration to troops Marmite is a pure extract of yeast and both in appearance, taste, and chemical analysis, is extremely like meat extract such as 'Lemco'; chemically, the chief difference is the absence of creatin and creatinine in marmite. It may be used in soups, or spread on bread or biscuits, etc. The ration is made up with sugar and pea-flour, etc., so as to contain 50 per cent. marmite, and is put up in ½ oz. cubes, each cube grooved so as to be divided easily into halves. One half cube should be issued twice weekly. It is soluble in warm water. There are three varieties made—with animal fat, with vegetable fat, and without any fat. The last two varieties only are suitable for Indians.

249. Pathology.—The essential lesions are (*a*) degenerations of the nerves more or less complete from the nuclear centres in the cord to the peripheral terminations, (*b*) cardiac degeneration, (*c*) inflammation of the duodenum, and (*d*) serous effusions.

250. Symptoms.—These are specially important in the prodromal and early stages, when treatment will soon be effectual. The prodromal period lasts for a few days to a few weeks, during which langour, dyspnœa, palpitation, numbness and cramps occur. The tripod gait (with legs outspread and a walking-stick) is a steppage and not an ataxic gait.

Early symptoms are:—Weakness of the legs, causing inability to march; dyspnœa on exertion; œdema of the legs; tenderness of the calves on pressure; dyspepsia and tenderness over the duodenum.

Anæsthesia and analgesia of the legs, producing abnormal sensations such as numbness, pins and needles, etc., and shown by inability to distinguish a pin-prick and a finger-touch, often occur. The knee jerks may be increased in the early stages but sooner or later they become diminished and lost.

One of the earliest symptoms, which should be borne in mind by regimental medical officers, is inability to assume a squatting position and rise again, with the hands kept to the side. This is known as the *jongkok* or 'squatting' test.

Dilatation of the heart commonly occurs at an early stage in the disease and in severe cases it may be acute, with a liability to sudden and fatal syncope.

The symptoms often appear suddenly. Men, apparently healthy one day on inspection, may exhibit the symptoms on the day following. A route march will sometimes bring out the disease, men reporting sick on arriving back though feeling quite well on starting. The signs seem often to be brought out by fevers.

251. Diagnosis.—This must be made from arsenical, malarial and alcoholic neuritis; post-dysenteric and post-diphtheritic paralysis; trichiniasis, ankylostomiasis, lathyrism (a spastic paralysis due to eating certain lentils); and malingering which may be distinguished by the presence of knee jerks.

252. Treatment.—Rest in bed and treatment of dyspeptic, cardiac, or other symptoms should be carried out. Correct the diet, which must be light and nutritious, according to the above table, having due regard to race prejudices. Marmite may be given. Alcoholic extract of rice polishings has also been used. Saline purges may be required and paracentesis for serous effusions. For the heart if urgent symptoms of dilatation arise, amyl nitrite minims 5, nitroglycerin gr. 1-100, or hypodermically trinitrin 1 minim, may be given. Contractures of the limbs must be avoided by massage, etc.

Prophylaxis.

253. Where rice is the staple article of diet it should be the brown undermilled form. Note that this is difficult to keep and is liable to become infested with weevils and other insects. This may be prevented without harm by placing, here and there

amongst the rice, bottles or tins containing chloroform or carbon tetrachloride.[3]

Early diagnosis and appropriate treatment are very important. It should be borne in mind that in Mesopotamia the experience of that campaign showed that Indians were practically free from the disease. This absence amongst Indians was probably due to the daily issue of dal which is rich in anti-beri-beri vitamines, and to the use of atta instead of refined flour.

It is important that British troops should receive a daily ration of either dal, peas or pea-flour, haricot beans or oatmeal, but the peas and beans should not be canned.

The establishment of vegetable gardens in standing camps and on the Lines of Communication should be undertaken early in a campaign which is likely to be prolonged.

Bilharziasis.[4]

254. This is one variety of a group of diseases properly called the Schistosomiases, as they are caused by certain members of the Family Schistosomidæ of the trematode class of platyhelminths or flat worms.

255. There are three species known to infect man, *i.e.*—

(1) *Schistosomum hæmatobium* Bilharz.

(2) *Schistosomum mansoni* Sambon.

(3) *Schistosomum japonicum* Katsurada.

The first is the cause of Vesical Schistosomiasis or Endemic Hæmaturia and occurs chiefly in Egypt, Syria, Uganda and South Africa. It has also lately been found in large percentages of the population in Mesopotamia.

The second is the cause of Rectal Schistosomiasis and is found in the West Indies, South America and the Congo Free State.

The third gives rise to a more general infection in the lungs, bowel, and liver, and is found in Japan and China.

256. Life History.—The first variety only need be described, *i.e.*, *Schistosomum hæmatobium* Bilharz, formerly called *Bilharzia hæmatobia* or *Distomum hæmatobium*. This is a flat worm occurring in pairs, the male being shorter, broader, and folded longitudinally to form a groove in which lies the longer and narrower female. It is found after death in the portal vein or its branches,

as far down as the vesical veins. They may be present in considerable numbers. The male is 11-15 mm. long and 1 mm. broad. The female deposits eggs which are oval, measure about 0·16 by 0·06 mm. and have a short spine at one end. These eggs project into the mucous membrane of the bladder and by their irritation cause cystitis and hæmorrhages, and lead to the formation of calculus. Later fistulæ from the bladder and urethra may occur. The eggs may also occasionally find their way to any of the other organs and set up inflammatory processes. By the time the egg has worked its way into the urine and is therewith voided, it is seen to contain an embryo or miracidium. This embryo is hatched out if the egg is passed by the patient or otherwise finds its way into water.

The free-swimming embryo can live for a very short time only in urine in which it may hatch out, and for about 24 hours in water To continue its existence it must find an intermediate host and this it does in certain species of molluscs. In Egypt these molluscs have been proved to be a species of Bullinus for *S. hæmatobium* and a Planorbis for *S. mansoni*. These are fresh water snails and it is probable that in other countries certain other varieties may also act as hosts.

Having gained an entrance into this host, the embryo gives rise to a sporocyst which latter forms daughter cysts (rediæ) These emerge from the mother cyst and enter the digestive gland of the mollusc where they produce cercariæ, which on the rupture of the sporocyst are discharged from the snail into water. This stage of development takes 3-4 weeks.

The free-swimming cercaria is the infecting form of the parasite. It gains entrance to the body through the skin and mucous membrane of the mouth and possibly through that of the genitalia, anus and nares. When penetrating the skin, the cercariæ leave their tails behind. The cercaria finds its way to the liver where it matures and the adults pass thence into the portal vein, thus completing the life cycle. An infected snail can be easily made out by putting it in a tube with some water and after a few hours (within 48 hours) observing the discharged cercariæ. Cercariæ of *S. hæmatobium* have a body provided with two suckers, an oral and a ventral one, and a tail bifid at its extremity by means of which it actively swims about.[5] These tiny creatures can just be seen with the unaided human eye when in clear water in a test tube. A lens is required for their detection

in natural water. To the naked eye they look something like a swarming mass of tiny white hairs. An infected snail goes on discharging them for several weeks.[6]

257. Important points to note are :—

(i) The embryo or miracidium is rapidly killed by dilute solutions of Hydrochloric acid of strength equal to that of the gastric juice.

(ii) The cercariæ are killed by gastric juice and by a 1 in a 1,000 solution of sodium bisulphate. They are also very susceptible to the action of dessication and are killed immediately by a temperature of 50°C.

They are not eliminated by sand filters and will even pass through 30 inches of sand in a Jewell filter after alum sedimentation.[7]

(iii) Both miracidium and cercaria are killed by a 1 in 10,000 solution of ordinary cresol Neither are with certainty killed by the ordinary chlorination of water, but 3 parts Chlorine in 1 million parts of water is said to be efficacious.

(iv) An intermediate host, a mollusc, is necessary for the production of the infecting form—the cercaria.

(v) The cercaria will only survive for 36 hours in fresh water.

(vi) Infection occurs through the skin and possibly through the mucous membrance of the mouth and other parts, but not from the alimentary canal.

From these facts it follows that :—

(*a*) The danger from drinking water is relatively slight.

(*b*) Water known to be free from molluscs by filtration or other means and stored for 2-3 days can be considered to be quite safe.

258. Incubation period—is given as 1½-3 months. The chief symptom is hæmaturia (or, in the other forms, passage of blood and mucous from the bowel). In some cases, especially among natives, the ova may be passed without any symptoms.

259. Diagnosis.—The diagnosis is easily made by sedimenting or centrifuging the urine and examining the deposit with a low power of the microscope. The ova are readily recognized.

Eosinophilia is always well marked, 30-60 per cent. and is usually associated with a leucocytosis.

260. **Treatment.**—No radical treatment is known. Attempts to kill the adult worm by salvarsan, etc., have failed. Local treatment for the cystitis, prolapse of rectum, vesical calculus, is indicated.

Prophylaxis.

261. Bathing or wading in any waters in infected areas must be avoided. Water supplied for bathing and ablution should be filtered or strained and stored for at least 48 hours. If this is not possible, cresol should be added to give a 1 in 10,000 solution, or lime, 1 in 1,000, which kills cercariæ in 30 minutes.

Where wading in waters is necessary for military reasons, canvas waders or other water-proof protection for the legs (see section 472) should be provided.

The disease is very chronic but symptoms tend to disappear in the course of 3 or 4 to 12 years where no re-infection occurs. For this reason it is essential that patients should be removed from infected areas. The urine and fæces of the patient should be disinfected.

262. **Important snails.**—Snails incriminated as intermediate hosts are:—

Planorbis boissyi
Planorbis olivaceus (*vel guadelupensis*)
which act as hosts of *S. mansoni*.

Bullinus contortus
Bullinus dybowski
Bullinus alexandrina
Bullinus innesi
Planorbis mareoticus
Planorbis pfeifferi
Physopsis africana
which harbour *S. hæmatobium*.

Blandfordia (*Hypsobia*) *nosophora*
which is the host of *S. japonicum*.

All attempts to infect indigenous Planorbis with miracidia of *Schistosomum hæmatobium* have so far proved unsuccessful. The following are the fresh-water snails most commonly found in the Bombay district—[5]

Ampularia dolioidis.
Vivipara bengalensis.
Vivipara dissimilis.
Melania tuberculata.
Limnœa pinguis.
Planorbis exustus.

Common in Northern India is *Planorbis convexiusculus.*

These snails cannot be recognised without reference to special works.

It may be mentioned that *Planorbis exustus* is sometimes found infected with the cercariæ of *Schistosomum spindalis* Montgomery, which gives rise to a disease in cattle somewhat similar to sheeprot.[8]

Cerebro-spinal fever.

263. Cerebro-spinal fever, with synonyms Acute Cerebro-spinal Meningitis and Spotted Fever, is a disease due to the *Diplococcus intracellularis* of Weichselbaum. It appears to be air-borne and directly transferred from man to man without the intervention of any intermediate host. Two factors are necessary; (*a*) infected persons, and (*b*) certain atmospheric conditions.

(*a*) Infected persons may be either patients suffering from the disease, or carriers who have usually been contacts. The germ lodges in the upper air passages, nose, pharynx and mouth, and the lachrymal secretions; the principal site being about the posterior nares. When the disease is prevalent, there are a good many more healthy carriers discovered than there are patients.

(*b*) A warm saturated atmosphere is required to facilitate the spread of the disease. The organism quickly dies out in a dry atmosphere and also at temperatures below 60°F. The disease spreads more frequently in cold weather but this is due to the necessary warmth and moisture being provided in badly-ventilated rooms.[9]

264. Symptoms.—Stiffness of neck; head retraction; Kernig's sign. Petechial or purpuric rashes are seen in some outbreaks, but are more commonly absent.

The symptoms may resemble those of relapsing fever.

265. Diagnosis.—This rests on finding the organism in the cerebro-spinal fluid obtained by lumbar puncture.

Lumbar puncture.—Put patient on side near edge of bed, knees well drawn up, head and shoulders thrown forward. See that there is a good light on the back and that no shadow falls on the operator's hand. After painting the skin with tincture of iodine and steadying the patient, thrust a long sterilized needle

with large bore into the intervertebral space which is on a level with a line touching the summits of the iliac crests and is between the 4th and 5th lumbar vertebræ. It should be entered about ¾ths of an inch to the right or left of the middle line and directed upwards and inwards. Puncture can also be made in the middle line, this needle pointing slightly upwards. The canal is reached at a depth of from 1-3 inches. Often considerable pressure is required to pierce the ligaments before entering the canal. According to the intraspinal pressure the fluid will exude in drops or in a continuous stream. Sometimes slight shifting of the needle in or out is necessary before the flow starts. The fluid is turbid in the acute stage. Care must be taken that it does not squirt on to attendants.

If the fluid does not flow, the patient may be asked to cough as this will sometimes start the flow. It may be allowed to escape till the rate of flow is about one drop every 3-5 seconds. It should be collected in a sterilized test tube or flask for examination, and be placed in an incubator as quickly as possible as the coccus soon dies.

Microscopically, in a positive case, there will be seen a great number of polymorphonuclear cells and the diplococcus lying in the cells. (In tuberculous meningitis the cells are chiefly mononuclear).

266. Treatment.—(i) Flexner's anti-meningococcic serum. (See section 408), (ii) Symptomatic. Watch for retention of urine and also for relapses.

Prophylaxis.

267. (a) **General.**—Probably the most important factor in preventing this disease is ample ventilation. Open air conditions of living should prevail as far as possible. This is much more easily carried out in India than in colder climates.

(b) *The patient* should be immediately isolated and all his feeding utensils kept separate. After convalescence he must not be discharged until 2 negative nasal swabs have been examined. Swabs are taken by passing up behind the soft palate an ordinary diphtheria throat swab, bent up at the end to a suitable angle. Wherever possible both patients and carriers should be kept altogether in the open air; failing this, then in an open air ward or its equivalent.

(*c*) *Contacts.*—All contacts should be isolated and swabs examined. Those found to have no infection should have their clothes and kit disinfected and they should then be moved to other quarters.

(*d*) *Carriers.*—Any persons found to have the organism should be kept isolated and treated until they are clear. Bedding, clothes, kit and quarters of all contacts, whether carriers or not, must be disinfected thoroughly, and whilst these contacts are isolated they should each have their own-utensils for feeding, etc., kept and marked for each one's separate use.

268. Treatment of carriers.—The best treatment is by inhalation in a room, the air of which is impregnated with chemicals by an atomizer. In a room of 750 cubic feet capacity a 1·2 per cent. solution of Chloramine is atomized with steam. 1 litre of the solution is sprayed into the room in the course of 15-20 minutes.[10]
Carriers stay in this for 15-20 minutes daily, breathing through the nose. A free secretion from the nose and throat occurs.

Instead of Chloramine, a 1 per cent. solution of zinc sulphate may be used, when for a room of the same capacity 1 litre suffices for 20 minutes. Eight carriers lie in the room for 5 minutes at a time, repeated daily for 3-5 days until swabs are negative.[11]

269. Conclusions.—The following summary[12] may be quoted *verbatim*.—

"Bearing in mind the Hippocratic aphorism (never more true than in relation to the meningococcus) that 'judgment is difficult and experience fallacious,' the following conclusions are cautiously advanced :—

(*a*) Carrier rates were generally higher than had been expected from previous experience in the autumn months.

(*b*) A high carrier rate usually denotes overcrowding and dangerously unhygienic conditions, even though no cases of the disease may have recently occurred.

(*c*) Whilst sporadic cases may occur in a military (as in any other) community with any carrier rate, anything approaching an epidemic of cerebro-spinal fever is heralded by a warning rise of considerable height in the carrier rate.

(*d*) Severe overcrowding will probably be accompanied by a carrier rate (serological) of at least 20 per cent. Twenty per cent. is indicated as the danger line in the War Office Memorandum on Cerebro-Spinal Fever (March 1917). A carrier rate of this height will usually imply that the mobilization standard (England) of 40 square feet per man has been infringed, and that beds in the unit examined, are less than one foot apart.

It should be regarded as a signal for prompt and effective action to diminish overcrowding, and to improve ventilation. The distance between beds is of paramount importance.

(*e*) Carrier rates between 10-20 per cent. are unsatisfactory, and imply a certain amount of overcrowding; they must be watched with suspicion.

(*f*) Carrier rates of from 2-5 per cent. may be considered usual under the best conditions obtainable in barracks and hutments.

(*g*) Under the same conditions of overcrowding, 'non-contact' carrier rates agree substantially with 'contact' carrier rates.

(*h*) Quite a moderate degree of 'spacing out' of beds combined with simple methods for improving ventilation are highly efficient agents in reducing high carrier rates.

(*i*) When a unit shows a high carrier rate, a distance of at least 2½ feet between the beds should be enforced. The 'peace' standard would, of course, be even more effective.

(*j*) The mobilization standard of 40 square feet per man is the 'Ultima Thule' of concession which military hygiene can, with safety, concede to military necessity."

Cholera.

270. Cholera is a disease of the small intestines caused by the vibrio of Koch. The symptoms are due to endotoxins liberated by the breaking down of the vibrio.

In sudden big epidemics the source of infection is probably always due to the presence of the vibrio in the water supply. In sporadic cases and small outbreaks the source is usually milk or food, and frequently uncooked fruit or vegetables, *e.g.*, man-

goes, melons, grapes, etc. Flies are carriers, and direct contact from patient to patient also occurs; but whatever the immediate source of infection may be, the real original source, whether in the general water supply or in any particular food, etc., is now known to be from carriers.

Under natural conditions the vibrio soon dies, generally surviving from 2-7 days according to the time of the year—withstanding the hot weather badly. Even in patients it only persists for a few days. Carriers, however, may pass the vibrio for three weeks and occasionally for two months, in which case the gall bladder has probably become infected.

271. Symptoms.—Profuse diarrhœa with rice water stools; on standing, white flocculi of intestinal epithelium appear below and a slightly opaque fluid above. Vomiting, cramps in the legs and great prostration quickly follow.

272. Diagnosis.—Depends on the above symptoms and the finding of the cholera vibrio in the stools.

273. Treatment.—(*a*) Alkaline saline intravenous injections.

(*b*) Calcium permanganate solution and Potassium permanganate pills by mouth.

(*c*) Atropine hypodermic injections.

(*a*) *Treatment by hypertonic solutions.*—This method has been evolved by Sir L. Rogers. The Tabloid Brand Equipment No. 363 containing a complete outfit for this purpose has been designed by Messrs. Burroughs and Wellcome, and is supplied to Field Ambulances, Casualty Clearing Stations, General Hospitals and Advanced Depots, Medical Stores.

The *original hypertonic solution* recommended was:—

		grs.
Sodium chloride	grs.	120
Calcium chloride	,,	4
Potassium chloride	,,	6
Water	pint	1

Sir L. Rogers has further improved this and now recommends that the *Potassium chloride* should be omitted and that at each repetition of the injection, and at the first injection in all cases

admitted late with suppression of urine for 24 hours or more, one pint of the following *alkaline solution* should be given :—

Sodium chloride	grs.	60
Sodium bicarbonate	„	160
Water	pint	1

The sodium bicarbonate should be weighed and wrapped in paper and sterilized in the autoclave, then added to the sterilized sodium chloride solution.

The hypertonic solution may be given as follows :—

(i) *Rectal* injection in mild cases with good pulse; $\frac{1}{2}$-1 pint every 2 hours at first and then every 4 hours until the reaction has taken place.

(ii) *Subcutaneously* in children, where difficulties arise owing to smallness of veins.

(iii) *Intraperitoneally* in adults where the finding of a vein has failed. A trocar and cannula is introduced in the middle line below the umbilicus. The foot of the bed must be raised.

(iv) *Intravenously.*—This is the method of choice and should always be done except for mild cases. The median basilic vein in front of the elbow is usually chosen. Other veins suitable are found at the internal malleolus of the ankle, or any prominent vein may be selected.

The indications for intravenous hypertonic infusion are :—

(*a*) Low blood pressure (70 m.m.). The blood pressure can only be determined by a sphygmometer, (one is supplied in the outfit).

(*b*) High specific gravity of the blood, 1063 or over. An apparatus is supplied for determining the specific gravity.

(*c*) Restlessness, cyanosis and cramps are the clinical indications in the absence of apparatus for (*a*) and (*b*).

274. Operation of infusion.—The arm above the vein is slightly constricted by a bandage, etc., to distend the vein. The skin over the latter is painted with tincture of iodine, and incision through the skin made, and the vein dissected out. This is facilitated by pinching up the skin in a longitudinal fold over the vein and transfixing this fold by the knife, taking care to avoid the vein and cutting outwards. The vein will be seen

lying in the floor of the wound. No anaesthetic is necessary. Two ligatures are passed under the vein, the lower one tied and the upper left as a slip knot. An oblique incision is made into the vein, taking care not to divide it completely; the cannula is inserted and the upper ligature tied over it. The bandage on the arm is then loosened and the solution can be run in.

If the rectal temperature is not high, the solution should be at blood heat 98·4°F. If the rectal temperature is 102°F. or over, that of the solution should be reduced accordingly, *e.g.*, 90°F. or lower in hyperpyrexia.

275. **Quantity for Infusion.**—In severe collapse, about four pints are usually required. If a sphygmometer is available, the solution should be given until the blood pressure is nearly normal, *i.e.*, 100-110 m.m. Hg.

The pulse is very little help. It usually becomes palpable again at about 80 mm. Hg., but the pressure above this cannot be estimated by the finger.

276. **Rate of Injection.**—This should be about 4 ounces a minute. Whatever apparatus is used, care must be taken that air is expelled from the tubing, etc., before inserting the cannula into the vein. A little of the solution should be allowed to run to waste.

In emergency, all the apparatus necessary for the above procedure is a sterilizer of some sort, douche can or other vessel, tubing, cannula, scalpel, forceps (dissecting), ligatures, and the hypertonic solutions. The solution can be run in from the vessel by siphonage.

Prophylaxis.

277. **Personal prophylaxis.**—When cholera has broken out, individuals should direct their attention to all means of improving their general health especially the digestive functions, and, secondly, endeavour to avoid every possibility of infection. Water or milk should only be taken if recently boiled.[13] All uncooked fruit and vegetables should be entirely avoided for the time being. All food not absolutely fresh and wholesome should be rejected. Ices should be stopped and the use of the ice chest discontinued where possible. Handshaking and unnecessary contact with people should be avoided. Drinking of dilute hydrochloric or sulphuric acid, 20-30 drops in a wine

glass of water three times a day, is recommended. Attendants on patients should be completely protected by overalls and should carefully disinfect their hands each time after handling the patient.

Prophylactic inoculation is advisable. (See Section 411.)

278. Patients.—Patients are best treated in special huts or tents, not in the vicinity of other buildings and highways, and at a safe distance from the hospital. They should be brought to this camp along with all bedding, clothes, charpoys, etc Infected charpoys are burnt, and bedding and clothing that cannot be sterilized must also be burnt Floors of huts, etc., should be thoroughly cleansed with strong cresol solution. All excretions of patients must be treated with either—

(*a*) Strong cresol solution, 5 per cent. strength (making $2\frac{1}{2}$ per cent. when diluted with the excreta in equal amount), or

(*b*) Fresh chlorinated lime, 33 per cent. Cl., 1 lb. to 4 gallons of water, used in the proportion of 2 tablespoonfuls to 1 pint of excreta ; or

(*c*) Quicklime Mix the latter with equal parts of water, add three more parts of water and of this slaked lime add an amount equal to that of the excreta.

With any of the above, excreta must stand for one hour before being buried deeply or otherwise disposed of. An alternative to the use of disinfectants is to provide a large cauldron, place this over a fire and keep water boiling therein. Bed pans and contents are inserted and are allowed to boil.

Special sweepers and bhistis should be detailed and special attendants who must be segregated near the camp. A solution of potassium permanganate should be provided in the camp for all to wash their hands in. Dilute sulphuric or hydrochloric acid in 20-30 minim doses may be given to all attendants, subordinates, etc. Separate latrines should be provided for attendants. All cases of illness must be reported at once and sent to hospital for observation and disposal.

279. Contacts.—(*a*) A segregation camp must be established at once, provided with an entirely separate establishment.

(*b*) Special latrines, cooking places, water supply (permanganated or otherwise sterilized), food stores, etc.

(*c*) Special sweepers for latrines.

(*d*) Special arrangements for replenishing of food supplies.

280. **Regiment.**—(*a*) The medical officer should immediately get into touch with local civil medical officers and endeavour to ascertain what local sickness there is; the method and plan of treatment and burial; the disinfection methods in practice; the principal markets, fairs, etc., held and to be held in the locality, and the main thoroughfares of traffic. He should then establish with them a co-operative notification system.

(*b*) A house-to-house or tent-to-tent inspection should be carried out by a responsible officer, including followers' and bunias' quarters, etc.

(*c*) Infected quarters must be vacated and floors disinfected with strong cresol solution, all barracks or tents thoroughly opened out and freely ventilated. Barracks should be left vacant for 7 days and then cleaned and whitewashed, etc.

(*d*) All charpoys, bedding, clothes, tents, etc., to be spread out in the sun daily.

(*e*) All wells to be thoroughly treated with permanganate of potassium (see Section 40) or other sterilizer, and only sterilized tins allowed to be dipped down for drawing water. These tins or buckets must not be capable of being removed from the well-side. Sentries must be posted at each well with strict instructions to prevent contamination.

(*f*) All fruit consumption should be stopped.

(*g*) Only cooked vegetables should be used.

(*h*) All milk must be boiled.

(*i*) Conduct a vigorous anti-fly campaign with special efforts to prevent flies settling on food and drinks.

(*j*) All old gurrahs and water chatties should be broken and new ones provided and sterilized.

(*k*) The use of massaks for carriage of drinking water must be prohibited.

(*l*) Ice, soda water, syrups, etc., should be under European supervision. Chlorinated water only to be used for manufacture of ærated waters. Where climatic conditions allow, ice should not be issued for the time being.

(*m*) Infected bazars must be placed out of bounds and men in the lines prevented from leaving regimental areas.

(*n*) All latrines to be treated thoroughly with saponified cresol 1 oz. to 6 gallons if the R-W co-efficient is 18. This measure aims only at repulsion of flies and not the disinfection of the contents.

(*o*) Provide potassium permanganate solution at latrines for hand washing, and *abdust* use, and also in dining tents.

(*p*) All drinking water should be sterilized by boiling or chemical means.

(*q*) All jharons and cooking utensils must be boiled thoroughly and cook-house floors and tables swilled over with cresol solution.

(*r*) All water-bottles must be sterilized.

(*s*) Men who have done a course of sanitary training should be picked out to supplement, if necessary, the regimental sanitary detachment, and the latter should be struck off all other duties and be employed only on work connected with sanitation of the lines.

(*t*) Daily inspection of all natives employed in barracks, punkah coolies, etc. All hawkers and unauthorized natives to be kept out of the lines. Regimental police to be increased in numbers if necessary.

(*u*) All men must be directed to report sick at once if suffering from diarrhœa.

(*v*) Carriers must be sought for, especially if the source of infection is not obvious.

(*w*) Prophylactic inoculation should be urged on everyone. (See Section 411.)

Dengue Fever.

281. Dengue fever is a disease caused by a filterable virus and transmitted by the mosquito *Culex fatigans* or Stegomyia. Synonyms are :—Dandy Fever, Breakbone Fever, Bouquet.

The disease usually occurs in well-marked epidemics. The filterable virus is present in the patient's blood from the 2nd to the 5th day of the disease. Injections of a patient's blood into others causes the disease. Transmission by the mosquito is not fully proved, though widely accepted. Experiments seem to show that the mosquito concerned is infectious immediately after taking up the virus and for 8-27 days afterwards. Recent experiments chiefly incriminate the Stegomyia.

282. **Symptoms.**—These are influenza-like and altogether the disease is not clearly definable from sandfly fever and seven days' fever The chief points are:—saddle-back temperature chart, *e.g.*, 3 days' pyrexia, one day normal and 2 days' pyrexia, the temperature frequently being highest on the last day. An initial rash, erythematous in character, usually appears on the face and may cover the whole or part of the body. More noticeable, however, is the terminal eruption which is roseolar in character and usually most profuse on the hands, wrist, elbows and knees. It remains at most for 2-3 days and is followed by slight desquamation.

The joint pains are typical and located in the tendinous insertions about the joints. They are frequently severe and usually fugitive, passing from the knee to the shoulder, wrist or ball of thumb, etc.

283. **Treatment.**—Light diet. Sponging with vinegar relieves irritation Phenacetin or Aspirin may be required for the pains. An alkaline diaphoretic mixture should be given and, during convalescence, tonics.

Prophylaxis.

284. The various measures directed against the mosquito, *i.e.*, destruction of breeding-grounds, etc., and the use of repellents, do not differ from those mentioned under Malaria (Section 334 *et seq.*) Patients should be kept inside mosquito nets.

Diarrhœa, Colitis and Dysentery.

285. This, from the sanitarian's point of view, is an important group of cases which, in the absence of laboratory methods, are difficult to distinguish. Under field service conditions complete laboratory investigation into all such cases becomes impossible, for which reason diagnosis must frequently rest upon clinical symptoms only and in these circumstances they will be classified for statistical purposes as follows:—

Diarrhœa.—Those cases in which there are frequent evacuations without blood or mucus.

Colitis.—Cases of diarrhœa with passage of mucus.

Dysentery.—Cases of diarrhœa with passage of mucus and blood.

Where the *Entamœba hystolitica* or *B. dysenteriæ* have been discovered, the word "Amœbic" or "Bacillary" should be inserted after "Dysentery."

It must be clearly remembered that there is no clinical criterion apart from the finding of the organism by which a definite diagnosis of dysentery can be made or excluded.

286. Diarrhœa.—Apart from the specific diseases, diarrhœa may occur as an epidemic. Decomposing food (ptomaine poisoning) or contaminated milk is a frequent cause, as also may be water, owing to suspended organic matter or inorganic salts.

287. Dysentery.—Dysentery is of two types :—

(i) Amœbic, due to the *Entamœba histolytica.*
(ii) Bacillary, due to *B. dysenteriæ* of the Shiga or Flexner type.

Amœbic Dysentery.

288. Aetiology.—The amœba appears to exist in three forms :—

(i) *Entamœba histolytica.*
(ii) *Entamœba tetragena.*
(iii) Encysted *Entamœba histolytica.*

The first form is the pathogenic variety but, as it dies almost immediately after leaving the body it is practically of no importance in the spread of the disease. Forms (ii) and (iii) are probably stages in the development of a protective phase for the amœba. The encysted form is highly resistant and may live outside the body almost indefinitely in the presence of a little moisture. It is this form which spreads the disease. From the cysts infection may occur by means of water, flies, wind, soiled toilet paper blown from latrines, and possibly also from dust. They are chiefly found in the solid or semi-solid fæces of the convalescent and in carriers. Flies have been definitely shown to transmit them from fæces to food. On being swallowed, the cyst wall is digested and the living pathogenic amœbæ develop.

The rat has recently been shown to suffer from amœbic dysentery and may play a part in disseminating the disease to man.[14] For practical purposes the spread of infection may be taken as due to convalescents of the disease, diagnosed or frequently undiagnosed, and to carriers.

289. Symptoms.—Diarrhœa with passage of blood and mucus; abdominal pain (tormina) and tenesmus.

Cases may be acute in which the symptoms closely resemble those of bacillary dysentery, or they may show all degrees of chronicity from the acute condition down to cases in which there are only occasional loose motions.

It is also important to remember that any of the above symptoms may be absent; *e g.*, a case may occur in which no diarrhœa and no mucus are seen but only streaks of blood.

290. Diagnosis.—Where possible this should be made in the laboratory, but repeated examinations of the stools may be necessary to find the organism. This remark applies to all forms of infectious bowel disease.

291. Treatment.—Emetine is the specific. The essentials in this treatment are that it should be given as early as possible, that it should be strictly continuous—no single day being missed—and that it should be efficient in dosage and duration Methods of administration vary, but it may be taken that for an adult

(*a*) not less than a total amount of one grain should be given daily,
(*b*) it should be continued for 10-15 days, and
(*c*) not more than a total amount of 15 grains should be given in one course.

It is usually given hypodermically as the hydrochloride of emetine. Local reactions at the site of injection may occur but, up to the total of 15 grains in a course, may be ignored.

The double iodide of bismuth and emetine is also very efficacious especially where cysts are found. It is given by the mouth and continued for 10-15 days. The daily dose is 3 grains and is best given in small gelatine capsules containing 1 grain each, the three capsules being taken in the late evening.[15]

A combination of the above methods may be employed, *e.g.*, Emetine hydrochloride, $\frac{2}{3}$rds of a grain hypodermically in the morning, with Emetine bismuth iodide, one grain by mouth at night.

Emetine in any form by the mouth tends to cause vomiting (in British more than Indians), but in reasonable doses this may be ignored. Carriers are best treated by emetine bismuth iodide.

Sometimes Ipecacaunha powder is efficacious where emetine fails. It perhaps has a more continuous or more powerful

action within the bowel. It is also cheaper. 10-30 grains may be given as follows, either treatment being administered at night:—

(*a*) As a bolus (one or more) with 5 grains of Tannic acid. If preferred it can be covered with salol and, for the first day or two only, it may be necessary to administer 15 minims of Tinct. opii five minutes before the bolus.

(*b*) As a mixture:—

Pulv. Ipecac	gr.	20
Acid. Tannic	„	5
Liq. Morph. hydrochlor . .	m.	10
Mucilage		q. s.
Aq Menth. Pip. . . .		to 1 ounce.

Symptomatic treatment should be carried out in all cases in addition to the above specific treatment

Occasionally the bacillary and amœbic forms of dysentery may be combined in one case. In such a case there would be the very acute onset typical of bacillary dysentery, and the laboratory report would show amœbæ, as this examination only takes a very short time, whilst 3 or 4 days at least are necessary to isolate *B. dysenteria*. In acute cases of dysentery, pyrexia and toxæmia practically always indicate a bacillary infection even though amœbæ have been found. In such cases it would be advisable to give anti-dysenteric serum as well as emetine.

Prophylaxis.

292. From what has been said it will be seen that the general hygienic measures, as in all these diseases, must be rigorously enforced and, in addition, special effort must be made to eliminate carriers.

Wherever possible, the stools of all patients suffering from dysenteric symptoms or chronic or recurrent diarrhœa should be sent to the laboratory one or more times.

Efficient and early treatment of cases and carriers by emetine is important. In any case where a diagnosis of amœbic dysentery is reasonably certain, emetine should be started at once. In watching cases in hospital it frequently happens that 6-8 daily examinations of stools have to be made before the entamœba is reported. There is some foundation for the assump-

tion that early treatment will kill off the amœba before the formation of cysts, and so prevent the occurrence of carriers. This consideration outweighs the desirability of waiting for an accurate diagnosis.

Cases of dysentery are best treated in a separate ward with separate and ample sweeper establishment and utensils of all descriptions. The bed pans should be stored in fly-proof safes. It would be advantageous if arrangements for microscopical examinations could be made, attached to the ward.

When the course of emetine is completed, the stools should be examined for *Entamœba histolytica* as follows :—

One examination during the first week
One examination during the second week

Four examinations during the third week on separate days.

If the organism is found, a further course of emetine bismuth iodide 3 grains daily for 18 days, and, if necessary, a third course of 3 grains daily for 24 days may be given.[16]

The following paragraphs are applicable to any of these infectious bowel diseases .—

The rôle played by dust and sand is well known They act as predisposing irritants which render the intestinal mucous membrane especially vulnerable and open to the inroads of the bacilli.

Sand has been shown to be a suitable nidus for various forms of protozoal life. At the camps on the seashore near Alexandria and at other desert camps in Egypt, it was demonstrated that the sand was often heavily infected with bacterial and amœbic life, thus proving, if proof were necessary, how important it is to ensure that cooking and feeding utensils and mess tins are cleaned with sand or earth that is above suspicion.

For cleansing purposes all cook-houses in all standing camps should, therefore, be provided with a box containing sterilized sand, woodash, or sand or earth dug up from a depth of 3 feet in a clean locality. For the front, this may be considered a policy of perfection; but it ought to be aimed at by all units as plenty of woodash is usually obtainable.

Whether the infection be bacterial or amœbic, efforts must be concentrated in definite directions, which are briefly as follows :—

Early detection, early isolation, early effective treatment of all cases.

(b) Rapid incineration of all dejecta from cases, or effective disinfection until this is possible.

(c) Control of all fly-breeding, destruction of flies and protection of dejecta and utensils from access of flies till they are efficiently dealt with as in (b) above.

(d) Erection of efficient cook-houses or cooking shelters for all ranks, to avoid sand and dust contamination, and provision of wire-gauze safes for storage of uncooked foods.

(e) Supervision of cleansing of kitchen utensils and utilization of ash, sterilized sand, or clean sand dug up from 3 feet depth for this purpose.

(f) Supervision of the efficiency of the cooking. Individual cooking by Indians should be discouraged, to allow of the heat energy of the firewood being used to its fullest extent.

(g) Erection of suitable dining room accommodation, either huts, shelters or marquees. In camps, much can be done with two or three I.P. tents and suitable excavation. All ranks, both British and Indian, should, where possible, construct dining shelters, and cease to have meals in the living tents.

(h) Careful watch on water purification, and on water storage utensils, *e g.*, water bottles, pakhals, Persian hubs, tanks, diggies and paulins. Men must not dip their own receptacles into tanks, etc. Dippers are essential and, where possible, a locked water-storage receptacle with stopcock should be used.

(i) Avoidance of chills when sleeping in the open, by wrapping a puttee round the abdomen.

Bacillary Dysentery.

293. **Aetiology.**—The method of spread and infection of this disease, is, from a sanitary point of view, almost identical with that of Enterica, *i.e.*, by means of water, food, flies and dust; indirectly and directly from patient to patient; and by carriers. The motions are highly infectious and by reason of their great frequency the dangers of dissemination of the infection are multiplied. Urine is not infectious.

294. **Symptoms.**—Acute onset and very numerous scanty stools of blood and mucus. A chronic form occasionally occurs.

295. Diagnosis.—Clinically on the above symptoms; bacteriologically by finding the bacillus in the stools. This takes a few days.

296. Treatment.—(*a*) Symptomatic.

(*b*) Saline injections as for Cholera.

(*c*) Polyvalent anti-dysenteric serum. (See Section 414.)

(*d*) Vaccines are useful in chronic cases and in relapses when anaphylaxis is feared owing to previous treatment with serum.

297. Prophylaxis.—In general principle this is the same as for enterica. Stress is to be laid on complete diagnosis of any suspicious case by bacteriological examination for the elimination of undetected carriers, and the thorough disinfection of everything that can possibly be contaminated by the numerous and infectious stools. Hands of everyone dealing with the patient should be immediately sterilized. Everything used for the patient must be kept for his separate use. Latrine seats, etc., which he may have used, require thorough disinfection by $2\frac{1}{2}$ per cent. Cresol solution.

Further bacteriological examinations are very advisable to ensure that the convalescent on returning to duty is free from infection.

Prophylactic inoculations with vaccines or sero-vaccines are at present on trial. (See section 415.)

Enterica.

298. Definition.—A group of diseases in all cases caused by one of the organisms *Bacillus typhosus*, *B. paratyphosus* A, or *B. paratyphosus* B. For statistical purposes this group includes the following:—

(i) Typhoid Fever, in which *B. typhosus* has been definitely isolated from the blood, urine, fæces or other discharge.

(ii) Paratyphoid A Fever in which *B. paratyphosus* A has been so isolated.

(iii) Paratyphoid B. Fever in which *B paratyphosus* B has been so isolated.

(iv) Enteric Group cases in which by clinical symptoms, the Widal test or other means, a diagnosis of one of the typhoid diseases has been arrived at, but has not been confirmed by isolation of the causal bacillus.

299. Aetiology.—For all practical purposes the disease may be presumed to be contracted *via* the alimentary canal. The means of infection may therefore be taken to be food and drink; the source has invariably been direct or indirect contamination from one or more persons suffering from the disease or in the 'carrier' state.

Indirect contamination.—(*a*) The excreta, urine or fæces of an infected person, deposited on or in the ground, soak into the ground water and are carried to the supply of water used for drinking and other purposes; *i.e.*, well, stream, spring or lake.

(*b*) Flies convey the infection from the excreta to milk, food, etc., or possibly dust blown by the wind may carry the germ.

Direct contamination.—(*a*) From a patient suffering from the disease either in the ambulatory or the acute stage. Attendants, therefore, are particularly liable.

(*b*) By carriers; *i.e.*, persons who may or may not have had the disease, but who constantly or occasionally pass the bacilli in their excreta. These are the commonest causes of sporadic cases or localized outbreaks. Experiments have proved that the hands of carriers are frequently infected and that in this way they convey infection to food and articles handled by them.

300. Symptoms.—It is only necessary to remark here that the symptoms have been profoundly modified in persons who have had preventive inoculation. Diarrhœa and severe prostration are uncommon in such persons.

301. Diagnosis.—In Typhoid Fever, Paratyphoid A Fever and Paratyphoid B Fever this officially rests on the finding of the causative organism.

Blood Cultures.—These are usually only of use during the first 5 or 6 days of the disease as the bacillus tends to disappear from the blood-stream about this period, though it may occasionally remain there up to the 12th or 14th day.

Fæces and Urine.—When the blood cultures have been negative, these must be repeatedly examined during the 2nd and 3rd week until a diagnosis is made.

Widal reaction.—The Widal test is most useful at four-daily intervals during the 2nd, 3rd and 4th week. A progressively increasing Widal reaction is a valuable sign.

The Atropine Test.—This, lately introduced, is especially valuable from the 5th to the 14th day, particularly in patients who have had antityphoid inoculation in whom the disease is

usually atypical and the Widal test is not so reliable. A hypodermic injection of 1-33rd grain of atropine sulphate is given. In a normal person this would, some time during the ensuing hour, cause the pulse rate to be increased by 14 or more beats per minute. If the pulse rate fails to be increased by that number per minute (*e.g.*, there is only an increase of 8 or 10 beats) or is actually made slower by the injection, then a positive reaction is obtained and the disease is almost certainly one of the enteric group.[17]

In hot climates, however, great discomfort and possibly some danger will arise from checking the perspiration.

N.B.—Every case of pyrexia in which the diagnosis is doubtful should have a blood culture done not later than the 5th day of disease if possible; failing this, as soon as the case is seen. A positive result obtained by this means saves endless time and trouble, and the value of an early diagnosis for the prevention of an epidemic is obvious.

302. Treatment.—This calls for no comment in this book (see, however, Section 420).

Prophylaxis.

303. This may be treated under three heads :—

(*a*) The patient.
(*b*) Attendants on the patient.
(*c*) General measures.

The patient.—Patients in Field Medical Units must be isolated as far as possible. In General Hospitals they will be treated in a separate ward Every patient should have all utensils—feeding, bed-pan, bottle, enema syringe, etc.—marked for his separate use. All his excreta—sputum, fæces and urine—must be disinfected by 5 per cent. Cresol solution or other disinfectant for an hour. They should then be incinerated or deeply buried Soiled clothing, bed linen, and blankets should be treated in the disinfector (Thresh's) or soaked in Cresol solution (see Section 169). Bed-pans, etc., should be stored protected from flies Feeding utensils should be boiled.

Attendants.—Scrupulous cleanliness of hands is the most important precaution. There should always be a bowl of disinfectant ready near the bed in which to wash the hands immidiately after every attendance on the patient.

General measures.—Preventive inoculation with T. A. B. vaccine is perhaps the most important single measure of prophylaxis. Its high value is now definitely accepted. Briefly stated, other prophylactic measures include all those taken to ensure an uncontaminated supply of food and water. The general question of a pure food and water supply is too big to be dealt with here (see Chapters I and II). The method of dealing with fly contamination is dealt with in Chapters III and VI. Certain other points which, with those mentioned above, are equally applicable in the case of cholera and dysentery are here given:—

(*a*) Protection of latrines from flies.

(*b*) Latrines must *not* be so placed that the ground water flows from them towards the water supply for troops.[18]

(*c*) Chlorination or other means of sterilizing water supplies must be carefully superintended.

(*d*) The health of cooks and all others handling food must be regularly watched and inquiries made regarding any present or past bowel troubles.

No man who has suffered from enteric fever should be employed in any capacity which necessitates the handling of food or water, until such time as repeated bacteriological examinations have proved him to be free from infection. In cases where means for carrying out such examinations are not available, these men must not be employed in the above capacities.

(*e*) Care in diagnosis of illness so that no undiagnosed case of Enteric, Dysentery, or Cholera may, after return to duty, become a source of danger.

(*f*) Medical Officers to bear constantly in mind the question of carriers.

(*g*) Complete disinfection of all excreta of patients or carriers of such diseases.

(*h*) Patients not to be returned to duty until they have been proved to have ceased discharging the organism in their excreta.

Gas Poisoning.

304. The gases used most commonly by the enemy are of three main varieties: [19]—

(*a*) Vesicants: *e.g.*, Dichlorethyl sulphide $(C_2H_4Cl_2)S$—mustard gas or Yperite.

(*b*) Suffocative: *e.g.*, Chlorine; Phosgene ($COCl_2$) Diphosgene, Chloropicrin. (CCl_3NO_2).
(*c*) Lachrymatory (purely): *e.g.*, Xylyl bromide, Cyanogen bromide, Bromacetone.

Gas may be liberated from cylinders (cloud gas) or from shells. The products of the explosive charge of any shell are another source of poisonous gases. In cloud gas attacks the gas is liberated from cylinders and drifts on the wind. In the use of gas shells the general aim of the enemy has been to fire simultaneously shells of different types, some of which will cause so much sensory irritation that the man will discard his respirator and then become vulnerable to lethal shells containing Phosgene and similar substances. Owing to this mixture of shells, the symptoms reported by patients are often very confusing.

German gas masks usually contained a layer of pumice with hexamethylenetetramine, charcoal and baked earth, saturated with potassium carbonate solution and coated with finely powdered charcoal Sodium phenate, reinforced with hexamethylenetetramine, protects against one part of phosgene in one thousand parts of air for a long time.

The following data may be useful:—

The distance in yards multiplied by 2 and divided by the speed of the wind in miles per hour, gives the number of seconds required for gas to reach the point of observation

BEAUFORT'S SCALE.		STRENGTH OF WIND.	
Beaufort's No.	Speed in miles per hour.	Observations on natural objects.	Behaviour of flag at top of vane.
0	0	Smoke straight up .	No movement.
1	2	Smoke slants . .	No movement.
2	5	Felt on face . .	Slight movement.
3	10	Paper, leaves, etc., moved.	Three-quarters up.
4	15	Bushes sway . .	Up. Falling often.
5	20	Tree-tops sway. Wavelets on water.	Up. Falling less often.
6	30	Trees sway and whistle.	Up. Flapping.

Action of gases.

305. **Vesicant.**—Dichlorethyl sulphide is the only one here described. It is an oily liquid used in shells and scattered from them on the ground, where it slowly evaporates. This not only attacks those in the immediate vicinity of the shell-burst, but may also affect those who may walk over the contaminated ground later. The fluid may be spattered also on clothing, shell casings, rifles, etc., and may thus become effective through direct contamination of the skin. The main action of this group is an irritant one on the skin, eyes and respiratory passages.

Special symptoms are:—(*a*) Early. These are insignificant, nothing being noticed immediately except a smell reminiscent of mustard, from which the gas derives its name. A soldier may not realize for many hours that he has been exposed to gas until the more important delayed symptoms develop.

(*b*) Delayed. There are the principal symptoms and appear 3-24 hours after being gassed. They occur usually in the following order and approximately after the intervals stated.

Conjunctivitis.—(3 hours) acute and severe, lasting up to several days.

Vomiting and Epigastric pain.—(4-8 hours). Apt to be persistent and intractable.

Burns.—(12 hours) Wide-spread erythema with local vesication occurs, going on to definite burns. The latter may occur anywhere but are commonest on the axillæ, genitals and back.

Laryngitis, tracheitis, bronchitis and pharyngitis.—(24-48 hours). These are the most dangerous. The degree may vary from a simple irritation to an ulceration of the whole passages, followed by infection of the raw surfaces. These lesions may be so extensive and severe as to cause death by themselves or in consequence of the development of broncho-pneumonia.

When a soldier is protected by a respirator, the respiratory and eye symptoms are absent or slight.

306. **Suffocative.**—The immediate effects of irritation of the eyes may be prominent at first but as a rule quickly pass off. Within 3-12 hours after exposure to the gas the main symptoms, asphyxia and prostration, due to affection of the lung alveoli and accumulation of fluid in them, appear. Rapid respiration and pain (often intense) in the chest, coughing and expectoration;

restlessness and anxiety, or there may be semi-coma and muttering delirium.

307. Irritant gases.—In addition to suffocative and vesicant actions, some gases also have an irritant effect. Pulmonary changes appear to be a necessary stage in all the pathological effects of the irritant gases mentioned below.[20]

Where the type is Phosgene, the lung alveoli are mainly affected, with consequent oedema of the lungs and great interference with absorption of oxygen.

Where the type is dichlorethyl sulphide, the air passages are chiefly affected and there is little or no œdema of the lungs but danger to life may arise from mechanical blocking of the air passages. There are, however, many gases which, like chlorine, act markedly on both the alveoli and the air passages.

The local inflammation and necrosis afford an opportunity for the development of infections which may lead to infective bronchitis and broncho-pneumonia, particularly in the second variety of pulmonary irritants.

Among the important symptoms of irritant gases generally are :—

(a) *Pulmonary.*—Early œdema and bronchial spasm. Later emphysematous and collapsed areas ; hyperpnœa.

(b) *Cyanosis* may or may not occur and is due to retained CO_2.

(c) *Anoxæmia,* as distinct from cyanosis and signifying lack of oxygen in the blood, causes ashy-greyness without marked breathlessness ; this condition is very grave, although the patient may be comfortable.

(d) *Heart.*—Early tachycardia is usual but may not occur. Right-sided dilatation is a more constant phenomenon, with accentuation of the second sound. Later during convalescence, tachycardia may occur, evidenced by an abnormally increased rate of beat during exercise and a slow return to normal on rest. Other changes characteristic of convalescence are :—" Effort Syndrome "—a term expressing the symptom complex of D.A.H. or irritable heart ; capillary hæmorrhages, especially in the brain ; and marked fall in blood-pressure.

(e) *Local.*—Hæmorrhages of the gums, acute pharyngitis and laryngitis with difficulty of swallowing are seen in non-fatal

cases, and later erosion of mucous membrane and sloughing may occur. In fatal cases the congestion of the larynx, trachea and œsophagus are marked.

(*f*) *Stomach and bowls.*—Gastritis, hæmatemesis and diarrhœa with blood and mucus sometimes result.

(*g*) *Renal.*—Albuminuria.

(*h*) *Blood.*—The blood becomes concentrated and there is polycythæmia (absolute), leucocytosis, and acidosis.

308. Summary.—Factors contributing to the above conditions are:—

(i) The direct damage done to the respiratory apparatus and pulmonary blood vessels.

(ii) Absorption by the actual gases inhaled or primary products of disorganized lung tissue.

(iii) Absorption by the blood of toxic substances secondarily produced in the lung or elsewhere.

(iv) Shock, however produced.

It cannot be stated, with certainty, that *all* the effects these irritant gases produce are secondary to deficient respiration; nevertheless, at present there is no evidence that the manifold signs and symptoms they produce within the body cannot be fully accounted for by reference simply to such deficient respiration and, in particular, to oxygen want. The shock may be due to actual damage to the lungs (as in a burn of the skin) or to the anoxæmia.

Treatment.

309. (*a*) *Rest* is required to diminish the need for oxygen, to decrease the formation of CO_2, and to prevent an increase of pulmonary pressure which favours the production of œdema.

(*b*) *Warmth.*—Clothes saturated with gas must be removed, but adequate covering must be substituted. Shivering and draughts increase metabolism and therefore the oxygen demand, the CO_2 production and the blood pressure. The air should be kept as *still* as possible.

(*c*) *Administration of Oxygen.*—This is most valuable and particularly so in those cases showing anoxæmia. It fails, however, in extremely severe asphyxial cases and in milder cases where there is no anoxæmia but much dyspnœa.

(*d*) Where circumstances permit, the outer clothing of such cases should be removed after they have reached the open air and blankets substituted before the patients are brought to the Aid Post or dressing station.

(*e*) Medical personnel transporting such cases should wear respirators until gas no longer emanates from the clothing.

Frequent surprise inspection of individual's respirators should be made by both medical and combatant officers.

N.B.—Phosgene gas is formed by the action of a naked flame of acetylene on chloroform vapour. If this illuminant is used in an operating room or tent, the products of combustion should be, if possible, led away by a pipe or chimney.

Heat effects.

312. The effects of heat group themselves into four ill-defined conditions, generally described as :—

Heat exhaustion,
Heatstroke,
Sunstroke.
'Effects of heat.'

Heat exhaustion is also frequently termed heat prostration and heat cramp (amongst firemen). Other terms, somewhat loosely applied to the more serious effects of heat, are :—Thermic Fever, Siriasis, Phœbism and Diathermasia.

313. Aetiology.—The exact pathology of these conditions is not known, but roughly it may be taken that the severe forms of heatstroke occur in great heats with exposure to the sun (or perhaps furnaces); whilst the lesser forms of heat exhaustion occur in the presence of great heat without such exposure to sun. Other factors also are present and perhaps necessary.

The relative amount of moisture in the air has a great effect. Thus, Haldane's experiments have shown that if the wet bulb thermometer rises to 88°F. in still air, or 93°F. in air moving at the rate of 170 feet per minute, or to 78°F. with leisurely work, some pathological effects appear and the temperature of the body begins to rise. (See section 322.)

The effect of the humidity of the air is in relation to the sweating, which is greatly decreased in a relatively high humidity,

and this acts by lessening the amount of heat loss and probably by the retention of certain deleterious matters which are normally excreted in the sweat. Further auto-intoxication is probably also induced by the increased metabolism occurring as the result of higher temperatures. The possibility of thermic fever being due to a germ infection has also been suggested.

314. Heat Exhaustion.—This condition is a state of faintness induced by heat and can occur in any climate It may be caused by wearing unsuitable clothing on a hot day; sitting near a fire or a ship's boiler; being in an over-heated room, etc. Possibly it is due to excessive dilatation of skin vessels and non-escape of heat from the body. Weak pulse, pallor and often a cold sweat on the skin occur. Treatment consists in removing the patient to the fresh air and a cooler atmosphere, dashing water on the face to stimulate but not to chill, and the use of stimulants.

315. Heatstroke.—A maximum dry bulb temperature of 110°F. and wet bulb temperature of 80°F. is approximately the danger line when cases may be expected. It may occur either out-of-doors or under cover, and appears particularly to attack persons not in perfect health—men debilitated by disease, or suffering from actual disease, febrile or otherwise; *e.g.*, malaria, dysentery, enterica, kidney disease, etc. It also frequently attacks persons suffering from conditions such as over-eating, alcoholic excess, acidosis, intestinal fermentation, and (a very common factor) constipation. Healthy men appear to be able to work under high temperatures provided they drink sufficient water to replace fluid lost by sweat, and to dilute and eliminate the products of metabolism.

The pathology of heatstroke is unknown, but appears to be associated with an arrest of the processes of the centres concerned with heat loss, for a marked feature in heatstroke is the dry hot skin and, until the skin of a patient begins to act again naturally, the danger is not passed.

316. Symptoms.—Preceding an attack frequency of micturition, giddiness, drowsiness, etc., are seen. The chief characteristics of the attack are hyperpyrexia and a hot dry skin. Three forms are met with; asphyxial, paralytic with deep coma, and psychopathic with delirium and delusions and a tendency to suicide. Unconsciousness with flushed face, cyanosis, and distended veins, deepens gradually into coma. Convulsions are often very severe.

317. **Treatment.**—The temperature should be reduced to 102°F. by application of cold;—baths, douches, friction with ice all over the body, and promotion of a free circulation of air. When thus reduced, cover with a light blanket and prevent by warmth any further excessive fall of temperature.

Venous distension often requires venesection, whilst convulsions may be relieved by lumbar puncture. The bowels should be emptied by enemata and any underlying cause, *e.g.*, malaria, also treated. Diaphoretics or sudorifics appear to be valueless in restoring perspiration.

Caution.—Fans should not be driven so fast as to check a gentle perspiration.

318. **Sunstroke.**—The ætiology of this condition is unknown; some have attributed it to an acute cerebral or cerebro-spinal congestion brought about by the action of the actinic or ultra-violet rays of the sun. Little value is, however, assigned to the use of non-actinic materials, such as red cloth, for the lining of helmets, etc. The onset is often very sudden, as if the patient had been struck down by the blow of a sandbag. In the diagnosis of this condition, cerebral malaria should always be excluded by blood examinations. Treatment is symptomatic and on the lines of that laid down for heatstroke.

Both heatstroke and sunstroke may have severe and permanent after-effects, impairing mental efficiency.

319. **Effects of Heat.**—Under this term are included cases of heat prostration, heat cramps, and febrile attacks which are often encountered in heat waves and in persons exposed for long periods to the sun. These febrile attacks, frequently designated "ephemeral fever," "ardent fever," "sun fever," etc., may be regarded as milder disturbances of the temperature mechanism considerably short of heatstroke, and occur in more or less healthy persons.

Prophylaxis.

320. (*a*) So far as possible troops should not be exposed to the sun during the hot hours of the day.

(*b*) An ample supply of drinking water (at least 2½ gallons per head per day) should be provided in the hot season.

(*c*) Goggles, helmet, and spine pad, should be worn by all men exposed to the sun; helmets must be worn in single-fly tents and in the shade of trees, etc.

(*d*) No alcohol should be drunk between sunrise and sunset.

(*e*) Tight clothing, especially at the neck, should not be worn Belts and coats may be discarded ; shirts should be worn outside shorts or trousers when working or marching, and be left open at the neck.

(*f*) Men suffering from constipation, headache, or fever, should report sick at hospital for treatment. The bowels should be kept regularly open to prevent auto-intoxication. In hospitals, hand punkahs should be provided.[21]

(*g*) The rate of marching should not exceed 3 miles per hour and any load should be carried towards the loins. Ventilation through the ranks is important.

(*h*) Avoid muscular fatigue, more especially with men who are obese or suffer from heart or lung conditions.

(*i*) Place no confidence in the wearing of red or orange-coloured clothing as the " actinic theory " has now few supporters.

(*j*) A dilute acid, *e.g.*, vinegar and water, to moisten the face produces a sensation of freshness and stimulates the respiratory reflexes.

(*k*) Provision of ice and cooling drinks when the wet bulb temperature approaches 80°F.

(*l*) Avoid lying down in any place possible to be exposed to the sun and never lie with the back upwards.

(*m*) Heatstroke stations together with a drinking post should be established on lines of march. The following equipment per station has been found suitable .—1 ice chest, 1 portable bath, 4 hand fans, 2 khas khas tatties, 1 charpoy, 3 water receptacles and stands, 6 chaguls, 2 enamelled mugs, 1 hypodermic syringe, 1 thermometer, 1 Higginson's syringe, 1 bed pan, and restoratives, pituitrin and digitalin.

Wet and dry bulb thermometer.

321. This consists of two ordinary thermometers mounted on a frame side by side, a short space between them being necessary. One of these has its bulb covered with muslin, and is kept constantly moist by being connected with a small vessel containing water. The moisture is maintained by capillary action of a piece of

cotton wick, which has been previously well freed from grease by being boiled in ether. The dry bulb gives the temperature of the air, whilst the wet bulb, in consequence of the evaporation going on constantly from its surface, gives a lower reading.

The difference between the two temperatures recorded, indicates the rapidity with which evaporation is proceeding, and since evaporation is faster as the air is drier, this variation is a measure of the dryness or moistness (otherwise humidity) of the air. If the air is saturated with moisture, no evaporation goes on and the two thermometers will record the same temperature.

In frosty weather, the muslin covering and the water in the vessel will frequently freeze, with the result that evaporation will not take place. In such an event it suffices to brush the frozen muslin over with cold water and allow this to freeze; at such time evaporation will be going on from the ice-surface, so that it is equivalent to having a damp but unfrozen bulb. Occasionally in thick fog or during very damp cold weather the wet bulb may read higher than the dry; the latter temperature is then to be taken as that of saturation.

322. Relative humidity.—This is merely a convenient term used to express comparative dryness or moisture. Complete saturation being assumed to be 100, any degree of moisture may be expressed as a percentage of this. Thus, if the relative humidity is stated to be 71, it is meant that the amount of aqueous vapour present in the atmosphere is 71 per cent. of the amount which would be necessary to saturate completely the air at the particular temperature and pressure at the time the readings were taken.

In order to find the relative humidity, the use of a table which has been worked out from numerous observations and certain mathematical formulæ, is necessary. Glaisher's tables are generally used and the following is an abbreviated table which will suffice for purposes where exactness is not required :—

Relative Humidity Table.

Air Temperature	DIFFERENCE BETWEEN THE DRY AND WET THERMOMETERS																														Air Temperature
F.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	F.
30	100	89	78	67	57	47	36	26	17	7																						30
35	100	91	82	73	65	54	45	37	28	19	12	3																				35
40	100	92	84	76	68	60	53	45	38	30	22	16	8	1																		40
45	100	92	85	78	71	64	58	51	44	38	32	25	19	13	7	1																45
50	100	93	87	80	74	67	61	55	50	44	38	33	27	22	16	11	6	1														50
55	100	94	88	82	76	70	65	59	54	49	43	39	34	29	24	19	16	10	6	1												55
60	100	94	89	84	78	73	68	63	58	53	48	44	39	34	30	26	22	18	14	10	6	2										60
65	100	95	90	85	80	75	70	65	61	56	52	48	44	39	35	31	28	24	20	17	13	10	6	3								65
70	100	95	90	86	81	77	72	68	64	60	55	52	48	44	40	36	33	29	26	23	19	16	13	10	7	4	1					70
75	100	95	91	87	82	78	74	70	66	62	58	55	51	47	44	40	37	34	31	27	24	21	19	16	13	10	7	5	2			75
80	100	96	92	87	83	79	75	72	68	64	61	57	54	51	47	44	41	38	35	32	29	26	23	20	18	15	13	10	8	6	3	80
85	100	96	92	88	84	80	77	73	70	66	63	60	56	53	50	47	44	41	38	36	33	30	28	25	22	20	17	15	13	11	9	85
90	100	96	92	88	85	81	78	75	71	68	65	62	59	56	53	50	47	44	41	39	36	34	32	29	26	24	22	20	17	15	13	90
95	100	96	93	89	86	82	79	76	72	69	66	63	60	58	55	52	49	47	44	42	39	37	35	32	30	28	25	23	21	19	17	95
100	100	97	93	90	86	83	80	77	74	71	68	65	62	59	57	54	51	49	47	44	42	39	37	35	33	31	29	27	25	23	21	100
105	100	97	93	90	87	84	81	78	75	72	69	66	64	61	58	56	53	51	49	46	44	42	40	38	35	33	31	30	28	26	24	105
110	100	97	94	90	87	84	81	78	76	73	70	67	65	62	60	57	55	53	50	48	46	44	42	40	38	36	34	32	30	28	27	110
115	100	97	94	91	88	85	82	79	76	74	71	69	66	64	61	59	57	54	52	50	48	46	44	42	40	38	36	34	33	31	29	115
120	100	97	94	91	88	85	83	80	77	75	72	70	67	65	62	60	58	56	54	51	49	47	45	44	42	40	38	36	35	33	31	120
125	100	97	94	91	88	86	83	80	78	75	73	70	68	66	64	62	59	57	55	53	51	49	47	45	43	42	40	38	37	35	33	125
130	100	97	94	91	89	86	83	81	78	76	74	71	69	67	65	62	60	58	56	54	52	50	49	47	45	43	42	40	38	37	35	130
135	100	97	94	92	89	86	84	81	79	77	74	72	70	68	65	63	61	59	57	55	53	51	50	48	46	45	43	41	40	38	37	135
140	100	97	95	92	89	87	84	82	79	77	75	73	71	68	66	64	62	60	58	56	55	53	51	49	48	46	44	43	41	40	38	140
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	

The reading of the dry bulb thermometer is taken and looked for in the vertical column at the extreme right or left hand of the table. The number of degrees of difference between the wet and dry bulb readings is then taken and looked for in the uppermost or lowermost horizontal line of the table; the figure given at the junction of the horizontal and vertical lines thus found, is the figure showing the relative humidity.

The degree of saturation affects the amount of drying power left in the air and so affects the amount of evaporation from the surface of the body as sweat, and in this way affects the heat regulation of the body. It should be noted that the amount of moisture from sweat that can be seen on the skin is the result of two distinct factors :—

(*a*) The amount of sweat secreted, which varies according to bodily exercise, temperature of the air, emotional states and various drugs.

(*b*) The relative humidity of the atmosphere which is only another way of stating the amount of drying power of the air. Thus, if the relative humidity were 100 per cent., the air would have no drying power and sweat would pour freely from the skin. If, however, the relative humidity were low, *e.g.*, 20-30 per cent., the drying power would be great and the skin would remain dry even during great exertion.

Jaundice.

323. A condition due to a suppression of the normal flow of the bile This stoppage is caused by blocking of the ducts which may arise from :—

(*a*) Mechanical obstruction by gall stones, pressure of new growths, wounds, etc. These causes require no further mention here.

(*b*) Simple inflammation with swelling of the mucous membrane and plugs of mucus. This is a fairly common condition in India and is due to extension of gastro-duodenal catarrh caused by indiscretions in diet, chills, etc. There is usually slight fever and a slow pulse.

(*c*) Inflammations caused by some specific organism. There is at present considerable confusion over these conditions, but as some of them are undoubtedly infectious, they are of importance to the sanitarian. The following account

would seem to sum up present knowledge. There appear to be three main groups :—

(i) *Jaundice* occurring in the course of various diseases, *e.g.*, relapsing fever, enterica, dysentery, malaria, black-water fever, bilious remittent fever (one of the forms of pernicious malaria).

(ii) *Bacterial Jaundice* which seems to be a more definitely differentiated bacterial infection of the bile tracts than the above, and is apt to occur epidemically; *e.g.*, 5,648 cases occurred in the South African War. It is probable that this is due to one of the coli group of bacilli. *Bacillus proteus* has also been thought to be the cause. In India and Mesopotamia the *Bacillus paratyphosus A* and *B* have frequently been isolated in these cases.

(iii) *Spirochætal Jaundice.*—This condition has apparently been described under several names; *i.e.*, Weil's disease Mediterranean yellow fever, Infective Jaundice, and Spirochætosis recurrens. The Royal College of Physicians have decided that it should be called *Spirochætosis ictero-hæmorrhagica.* It has been definitely shown to be due to a spirochæte which was discovered by Inada and Ido, two Japanese workers, in 1914.

324. **Mode of infection.**—The method of infection of the bacterial type is probably exactly the same as for the enteric group of diseases; flies being probable carriers of the germ to food from faeces and urine

In the spirochætal form the method is not known but the spirochæte has been found in the field rat and the latter is therefore suspected. In the excreta of patients the organism is found chiefly in the urine.

325. **Symptoms.**—In the bacterial type the symptoms are largely those of enteric, usually fairly mild, with the addition of jaundice, and it may start with a rigor.

In the spirochætal form, pyrexia with jaundice on the 2nd to 7th day, hæmorrhage from the nose, lungs and gastro-intestinal tract and a remission of temperature followed by a secondary rise, give an unmistakable picture. But milder cases occur in which the secondary rise and hæmorrhages may be absent.

326 **Diagnosis.**—(*a*) For the bacterial type, early blood culture and later, examination of fæces and urine.

(b) In the spirochætal type, examine the blood during the first 7 days, after which the organism is absent from the blood. This examination may be carried out either by the dark-ground illumination method; the Indian ink, collargol or Congo Red method; or by staining with Geimsa, etc. By inoculating the blood of a patient into a guinea-pig, the disease is reproduced and the organism can be recovered. From the 9th day the organism can be found in the urine after centrifuging.

(c) The atropine test (see Section 301) has been used to diagnose mild cases from enterica.

327. **Treatment.**—Salvarsan and allied substances have been found useless. Inada and Ido have prepared a serum which is being tried.

Prophylaxis.

328. In the bacterial form, as for enterica. In the spirochætal form, isolate patients for 6 weeks; disinfect and incinerate sputum, fæces, and especially urine for 40 days, during which time the urine contains the infection. Rat destruction is indicated.

Malaria.

329. A disease caused by three or more species of the genus Plasmodium of the protozoa. The synonyms are numerous:—remittent fever, intermittent fever, ague, marsh fever, paludism, jungle fever, Peshawar fever, terai fever, Dum-Dum fever, or simply "fever."

There are three essentials in the causation of the disease:—

(i) The infective organism.

(ii) The definitive host:—certain species of the Anophelinæ which constitute a sub-family of the Culicidæ or mosquitoes.

(iii) The intermediate host:—man.

Accumulated experience shows that man is not susceptible to any of the malarial infections of animals and that the three (possibly four) human species of plasmodia can only exist in man as the intermediate host, and in certain species of anopheline mosquitoes as definitive hosts.

330. **Malarial plasmodia.**—There are three species of human plasmodia, *i.e.*—

(i) *Plasmodium vivax* which gives rise to benign tertian fever and has a non-sexual life cycle of 48 hours.

(ii) *Plasmodium falciparum,* which causes malignant tertian fever and has a cycle of 48 hours.

(iii) *Plasmodium malariæ,* which causes quartan fever and has a cycle of 72 hours.

The claims of a fourth (*Plasmodium tenue*) to being a distinct entity are still unsubstantiated.

P. vivax and *P. falciparum* are the common forms in India. The young parasite or sporozoit is admitted to the blood stream by the bite of an infected mosquito; it enters a red blood corpuscle and commences development. The mature parasite splits into numerous young ones or merozoits which burst out of the corpuscle and entering other corpuscles commence a second cycle. The duration of each cycle corresponds to the attacks of fever, once the infection is great enough to induce pyrexia. The setting free of the young parasites into the blood stream coincides with the commencement of the paroxyms in the patient.

331. **The Mosquito.**—For description see Section 205. In an infected mosquito the parasite occurs in the saliva. As the mosquito, preliminary to withdrawing blood into its stomach and possibly with a view to preventing clotting in the puncture-wound, injects saliva when biting, the parasite at the same time gains admittance. The mosquito to become infective must have previously bitten man in whose blood the sexual forms of the parasite must be present.

332. **Man.**—The reservoir of infection is man and consists of persons who are in the active or quiescent stages of the disease, and others who by reason of a partial immunity to the lethal effect of the parasite and the fever caused by its toxins, are unaware that they are infected and so constitute ambulatory carriers The latter group forms the larger reservoir.

333. **Epidemiology.**—To apply rationally the principles of prevention, it is essential first to understand the factors governing the origin, maintenance and explosiveness of malaria in a community. The three fundamental factors have already been mentioned. Considering these broadly, if any one is absent, malaria cannot exist; a logical sequence of this is that any campaign which reduces the size of any one of these factors tends to act beneficially in stamping out the disease. The degree of reduction necessary to effect any variation in endemicity, the factor or factors which may be attacked most advantageously, and the

choice of the many measures available against each factor, form a problem requiring for its solution the considered judgment of several experts and not only that of the malariologist.

Looking at the problem from another point of view, take first an inhabited district free from malaria but harbouring a specific anopheline. The introduction of the parasite into this district by the entry of infected human beings, leads to a spread of the infection and at first, in all probability, a mild or severe epidemic will occur amongst the susceptible inhabitants.

Depending now upon the densities both of anopheline and human populations, and assuming these to be constant (in reality, they must fluctuate), an endemic rate of sickness will eventuate in time, when the rate of cures (spontaneous or deliberate by treatment) will be equal to the rate of fresh infections If the density of the anophelines be now increased, the endemic rate will rise to a higher level.

These considerations bring out clearly several important points. Firstly, the necessity of guarding a susceptible population from the introduction of a foreign disease; secondly, the importance of measuring the endemic rate in an infected locality, as this indicates the chance of infection; next, the object of organized treatment to accelerate and multiply cures in the hope that these will rise in numbers above the numbers of fresh infections; and finally the importance of preventing, if reduction be impossible, an increase in the mosquito population.

Antimalarial measures.

334. The problems of malarial prevention and the means of effecting this, are subjects too big to deal with in detail in this book and it must suffice to give a brief summary of the known methods, discussing only those which are more applicable to field service conditions.

Mosquito reduction.—(*a*) Larval—

(i) *Oiling*—crude oil, kerosene, etc.

(ii) *Drainage*—gutters, ditches, gardens, marshes, etc.

(iii) *Cementing*—Pools, holes in rocks, forks of trees, bamboo stumps.

(iv) *Removal of vegetation*—parasitic tree growths, weeds in gutters, ponds, drains, etc.

(v) *Introduction of natural enemies into breeding areas*—*Notanecta glauca*, larvæ and full-grown beetles of the *Dytiscidæ;* Fish:—fresh and brackish water,—Genera *Haplochilus, Panchax, Polyacanthus, Therapon*, tanks and rivers,—Genera *Chela, Rasbora, Nuria*, Wells,—Genera *Barbis* (smaller species) *Haplochilus, Panthax, Rasbora, Nuria*, hill waters,—Genus *Barilius*.

NOTE.—Surface weeds and debris must be cleared and large predaceous fish, *e.g.*, Murrel, Wallago, removed; whilst netting by fishermen must be prohibited.

(vi) *Screening of breeding waters.*—cisterns, wells, fire buckets.
(vii) *Treatment of ditches, streams, rivers*—oiling, rough canalization, paving of beds, prevention of inundations.
(viii) *Treatment of waste tins, chatties, jam pots, etc.*—burial, perforating, etc.
(ix) *Treatment of ponds*—draining, oiling, filling in or deepening. Ditching to lower the sub-soil water.
(x) Afforestation or deforestation.

(*b*) Adult—

(i) *Fumigation*—sulphur dioxide, formaldehyde, country tobacco burnt with paraffin, pyrethrum powder, camphor and carbolic acid mixed and heated.
(ii) *Mosquito traps*—kerosene tins, lamp-blacked inside, with lids.
(iii) Netting and destruction by hand.

(*c*) Negative preventive measures—

(i) Piping of water supplies.
(ii) Water-carriage system of sewage disposal.
(iii) Prohibition of wet cultivation in vicinity.
(iv) Prohibition of excavations, brick fields, embankment construction, etc.
(v) Judicious relief of regiments and choice of their station.

Protection of the healthy.

(i) Maintenance of general health.
(ii) Quinine prophylaxis.
(iii) Protection from bites of anophelines.
(iv) Isolation of healthy from infected population.

Protection of the infected.

(i) *Segregation from healthy.*—Treatment in mosquito-proof wards, isolation, dispatch to hill station.

(ii) Complete eradication of infection.

Adjuncts to above.

(i) The use of spot maps to indicate breeding places and cases of infection.

(ii) Estimation of parasitic and splenic indexes.

(iii) *Education*—literature, lectures, placards, orders and imposition of fines and penalties.

(iv) Formation of mosquito brigades and gangs, and continuity in tenure of all appointments including that of the directing malariologist.

335. Oiling of pools, etc.—The object aimed at is to produce a thin film of oil on the water surface, which either annuls the surface tension of the water or deprives the larva of access to air or exerts a poisonous action on the larva.

Whatever oil is used it should be non-volatile, otherwise the effects are short-lasting.

Heavy oil of a density of 0·925 mixed with petrol in the proportion of 9 parts to 1, spreads uniformly and lasts longer than kerosene films. It is liable to kill fish and clog the plumage of birds.

The Panama larvicide is made as follows —150 gallons of crude carbolic acid of specific gravity not greater than 0·97 and containing not less than 30 per cent. tar acids, is heated to 212°F., then 200 pounds of powdered common resin are poured in. The mixture is kept at a temperature of 212°F. Thirty pounds of caustic soda dissolved in 60 gallons of water are then added and the solution is kept at the same temperature until a perfect dark emulsion without sediment is formed. After the resin is added, the mixture is constantly stirred. One part of this emulsion to 10,000 parts of water is said to kill anopheline larvæ in less than ½ hour. It is mixed with 5 parts of water and sprayed upon pools; the addition of crude petroleum favours its spread upon the surface of the water.

Crude petroleum may be used, about ½ pint being required for every 100 square feet of surface; the process should be repeated every two weeks.

This process is most suitable for stagnant waters as, if there is an overflow, the oil is soon carried off. Constant winds are detrimental to the success of this measure as the oil becomes driven to one side. Slow running streams, irrigation canals and ponds may be oiled automatically by fixed oil drips or floating buoys provided with drips.

336. **Larvicides.**—Other larvicides that have been used in water not used for drinking purposes are:—sulphuric, hydrochloric and other acids, potassium permanganate, sulphate of copper, sulphate of iron, perchloride of mercury, carbolic acid, anilin products, or coal tar. All must be used in relatively large amounts to be effective.

Powdered cork has been recommended for wells. This acts both in preventing adults laying their eggs in the water and also in suffocating any larvæ present. Buckets splashed on the surface divide the film, which unites again after the water has been withdrawn.

The ordinary chlorination of water for drinking purposes has no action as a larvicide. One part of Chlorine in 10,000 parts of water is required before a lethal effect is produced.

337. **Fumigants.**—Sulphur dioxide is probably the best and is used in quantities of 2 lbs. of sulphur to each 1,000 cubic feet of air space. Two hours exposure is sufficient to kill mosquitoes. Because of its deleterious effect on paintings, fabrics, metal work, musical instruments, etc., its use as an insecticide is limited and pyrethrum powder is substituted. This also is used in the proportion of 2 pounds per 1,000 cubic feet of air space, but the exposure should be 4 hours. As its insecticidal effect, is uncertain, it is necessary to sweep up and burn all the mosquitoes that have been stunned and are apparently dead after the fumigation. If all windows but one are darkened, the mosquitoes in seeking to find an exit from the fumes, are attracted to the light and most of these will be found stunned or dead on the floor close to the window.

Camphor-phenol or camphophenique, prepared by rubbing up equal parts of phenol crystals and camphor, gives off dense fumes when moderately heated. These rise rapidly and diffuse slowly. Like pyrethrum, it stuns but does not invariably kill mosquitoes. It does not tarnish metals, rot fabrics or bleach pigments but it softens varnish. The fumes are irritating to the mucous mem-

branes and may give rise to mild symptoms of carbolic poisoning in susceptible individuals. It is used in the proportion of 4 ounces to each 1,000 cubic feet of air space and the exposure should be for 2 hours. If overheated, it takes fire when its culicidal action is lost.

Geimsa's spray consists of 480 grammes of pyrethrum tincture (20 parts powdered pyrethrum blossoms to 100 parts alcohol), 180 grammes of odourless potash soap and 240 grammes of glycerine. Before use it is diluted with 20 times its own weight of water and is then used as a spray.

338. **Maintenance of general health.**—The chief points, in the prevention of malaria, are:—(*a*) *protection from the sun.* This applies not only to the healthy but in particular to the infected, who appear to be more liable to heatstroke and effects of heat. (*b*) *Working hours*—where feasible, *reveille* should not be before 5-30 A.M. and work should not commence before 7 A.M., breakfast being eaten in the interval. Where possible, the principal meal of the day should be at the tea hour, with a light mid-day meal.

(*c*) *Clothes*—chill after exercise and in the cool evenings should be avoided.

339. **Quinine prophylaxis.**—Innumerable methods of carrying out quinine prophylaxis have been advocated: best known are:—

(*a*) *Celli's method.*—3 grains of quinine each morning and each night.
(*b*) *Bertrand's method.*—Two consecutive doses of 5-10 grains every seventh or eighth day for benign infections and two consecutive doses of 10-15 grains every third and fourth days where malignant tertian infection is prevalent.
(*c*) *Ziemann's method.*—15 grains every fourth day.
(*d*) *Nocht's method.*—12 grains on two successive days of each week in divided doses of 2-3 grains.
(*e*) *Koch's method.*—15 grains on the tenth and eleventh days.
(*f*) *Castellani's method.*—5 grains daily and a double dose once a week.

Opinions are very divided as to the efficacy of quinine prophylaxis and it is sufficient to say that under field service conditions in intensely, malarious countries, the experience of the Great War has been that it should rank low in the list of measures that may be enforced.

340. Protection from bites.—The measure which affords the longest protection is the provision of mosquito curtains for use at night. The mesh of netting should not be less than 18 strands to the linear inch, mosquitoes can pass through a mesh of 15 strands. The weft and warp should be knotted, otherwise the least scratch draws them apart and leaves a hole. Bell-shaped and *tente d'abri* patterns are not as satisfactory as rectangular nets, which are less liable to allow the hands and arms to touch the sides.

When issued to troops, all ranks should be instructed in the proper method of their use. They should be in position ready for use before sundown, when contained mosquitoes and holes in the netting can better be detected. All nets should be inspected daily by a company or platoon officer. Holes should be darned and not gathered up. Mosquito nets can often be hung from wires stretched across a room as efficiently and more economically than if separate poles are used for each bed. For special conditions, special patterns may be required, *e.g.*, bivouac nets linings for circular tents, etc.

Windows, doors and even rooms may be protected with wire gauze or cotton netting.

Electric fans and punkahs are credited with effecting a 50 per cent reduction of mosquitoes in a room. The use of hand punkhas and the constant movement of the exposed parts of the body diminish the chances of being bitten. Veils, particularly for men on evening and night guard duty, are very useful in protecting the neck and face.

Much can be done to reduce the risks of being bitten by avoidance of infected localities and unprotected institutes, especially from one hour before sunset to one hour after sunrise. In the same way, working and meal hours should be fixed at appropriate times. Walls, clothes, curtains, bed spreads, etc., should not be dark-coloured.

Finally, mosquito repellents may be used on the uncovered parts of the skin. Neal recommends the use of Epsom salts. A solution of this is made by dissolving 1 ounce in 10 ounces of water; this is washed over the skin and allowed to dry. Of volatile substances, spirits of camphor, oil of pennyroyal, oil of peppermint, cinnamicaldehyde, safrol, menthol, eucalyptus, turpentine, vinegar and oil of citronella have all been recommended. Citronella oil, pure or mixed with carbolic acid, though

frequently used, is inferior in lasting power to oil of cassia, oil of cloves, or good quality oil of sassafras. A preparation known as Bamber or bamber-green oil is made up as follows :—

Oil of Citronella . .	. 1 part	or $1\frac{1}{2}$ parts.
Coconut oil . .	. 2 parts.	2 parts.
Kerosene oil .	. 1 part	1 part.
Carbolic acid to make	0·5 per cent.	1 per cent.

Another liquid preparation has the following formula :—Menthol, 1 dram ; Turpentine to 1 ounce. The same ingredients can be made into a paste as follows :—Menthol 1 lb., Turpentine 1 lb., Pulv. saponis 10 ounces

341. **Isolation of healthy.**—In a malarious district the fact of malaria must be almost the chief consideration in choosing the site for a camp. Valleys, ravines, the neighbourhood of rivers, streams, lakes and marshes, the proximity of woods or extensive undergrowth, and the vicinity of occupied native villages must all be avoided. In valleys, camps in the foot-hills are particularly liable to malaria attack.

Camps or quarters for civil labour personnel, employees of contractors, etc., should be sited at least $\frac{3}{4}$ mile in a straight line from any camps or quarters for troops.

In the case of muleteers, labourers, etc., attached to units, their camp should be on a site distinctly separate and as far as possible from the camp occupied by troops

342. **Determination of the Splenic index.**—As many children between the ages of 2 and 10 years should be selected. Young babies and youths should be omitted. Results should be tabulated as follows :—

(i) Spleen not palpable.

(ii) Spleen palpable or one finger's breadth below costal margin.

(iii) Spleen two to three finger's breadth below costal margin.

(iv) Spleen a hand's breadth below costal margin.

(v) Spleen to umbilicus or beyond.

Sanitary officers of divisions, areas, etc., will find that the making of spot maps is of value for initiating and supervising anti-malarial measures, and all information collected under this heading should be forwarded to them as soon as possible.

Mediterranean Fever.

343. A disease caused by the *Micrococcus melitensis.* Synonyms are Malta, Undulant, Gibraltar, Neopolitan and Cyprus fever; febris sudoralis (from the night sweats); Mediterranean phthisis (from the bronchitis, anæmia and night sweats); Melitensis septicæmia and Febris melitensis.

Whilst principally known in the Mediterranean area, this disease is widespread and is known to occur in India. It may be regarded as food-borne, and almost entirely by milk and any of its products, *e.g.*, butter, cheese, etc., since souring of milk does not destroy the germ Infection by dust inhaled, and through a skin wound, may occur but is rare. There is a strong probability that it may also be transmitted by sexual intercourse. There is no evidence of infection by insect bites but flies can almost certainly convey the germ to food. The goat and goat's milk are the principal agents in spreading the disease.

The micrococcus is one of the smallest pathogenic cocci. It occurs principally in the blood and is excreted freely in the urine and fæces. It is very resistant to drying and persists in dust for long periods. Infection has been common amongst laboratory workers.

344. Symptoms.—These are very numerous and not very characteristic, especially in the early stages, so that the disease is usually diagnosed as typhoid or phthisis, etc., until the prolonged undulating nature of the temperature becomes manifest.

The cycle of the attacks takes about one month, *i.e.*, about 10 days with a step-like rising temperature, a few days with sustained pyrexia, 10 days with step-line falling temperature, and then a few days' interval. There is a daily morning remission and evening rise of temperature accompanied by sweating. Relapses are numerous, the disease often lasting for nearly a year.

345. Diagnosis.—This is difficult in the early stages unless a blood culture is done. This is a marked instance of the importance of always taking a blood culture in any febrile case immediately that negative examinations for malaria have been obtained In any prolonged fever in which the diagnosis is doubtful. always think of Mediterranean fever.

346. Treatment.—This is still largely symptomatic. Recently intravenous injections of 5-10 c.c. of a 5 per cent. solution of

Kehlbaum's starch have been recommended.[22] Sera and sero-vaccines have been tried, but the most promising results seem to have been derived from the use of autogenous sensitized vaccines. [See Sections 421, 422.]

Prophylaxis.

347. (*a*) Careful disinfection and destruction of the excreta of all patients, especially the urine, the methods being those for enterica, cholera, etc.

(*b*) Issue condensed milk in lieu of all fresh milk, where possible.

(*c*) Failing this, boil all goat's milk before use; and kill and incinerate or deeply bury all infected goats.

(*d*) Isolate human carriers when found.

Oriental Sore.

348. A cutaneous lesion caused by the *Leishmania tropica.* Synonyms are:—Delhi boil, Aleppo sore, Baghdad boil, Frontier sore, and Cutaneous Leishmaniasis. Of pyogenic origin and having no relation to Oriental sore are Veldt sore, Trench sore, Nile boil and Bucharest sore.

The condition is caused by an infiltration of the corium and its papillæ with plasma, lymphoid and large phagocytic cells, the last packed with Leishman-Donovan bodies. It is probably contagious from case to case and also from dogs which suffer from this disease. Possibly it may be transmitted through the laundry but recent work suggests forcibly that infection is insect-borne and by means of insect bites, as sores occur with much more frequency on exposed parts of the body. Sandflies especially are suspected. The virus is not inoculable through the unbroken skin. An attack produces a somewhat prolonged immunity.

349. Symptoms.—Oriental sore commences as a small red papule like a mosquito bite, which persists, and ultimately the "blind boil" breaks down into an ulcer. It usually takes 3-4 months to arrive at this stage; then, after about a year, healing eventually occurs. As the disease is auto-inoculable, there are usually two or more sores.

350. Diagnosis.—Suspected sores should be examined microscopically. Pus or scrapings from granulations stain well with Leish-

man's or Geimsa's stain. Better results are obtained by puncturing the unulcerated margin of the sore and making a film from the serum which exudes. The parasite is characterized by having two nuclei which must be seen before a diagnosis can be positive.

Cultures of the parasite can be made in Novy-MacNeal-Nicolle 'N.N.N.' medium consisting of blood, salt, and agar.

351. **Treatment.**—Tartar emetic intravenous injections are a specific. 2-10 c.c. of a 1 per cent. solution in sterilized saline may be given daily for 4 or 5 days.

Carbon dioxide snow applied locally is usually curative. Potassium permanganate may also be applied locally, at first pure and then as a 5 per cent. ointment for 2 applications; it is however extremely painful.

Salvarsan and allied drugs are useless. Severe cases of ordinary pyogenic boils which are very common in the tropics and often crippling, should be treated with vaccines. Stannoxyl, a lead-free preparation of tin and its oxide, has been reported to have met with great success. The drug is administered orally in tablets weighing roughly 0·25 gramme, 4-6 tablets a day.

Prophylaxis.

352. Prophylactic measures directed solely against oriental sore will rarely be necessary; as, however, wounds and abrasions on field service are a cause of inefficiency besides involving risks of tetanus, it should be impressed upon all men that early treatment and protection are essential. Actual oriental sores must be kept covered, and touching and scratching them be avoided.

Where troops are affected in appreciable numbers, attention should be paid to fly nuisance, and the wearing of shorts, etc., which expose the skin, may prove to be an important factor and need to be discontinued.

Plague.

353. A disease caused by the *Bacillus pestis*. This disease is primarily one of rodents, especially of rats, but many other animals may be affected. Mice, guinea-pigs, the donkey and monkeys have at times been found infected, whilst the marmot, mongoose, squirrel, bat, jerboa, etc., are all highly susceptible. It is possible that all domestic animals may suffer but for practical purposes rats are the most important.

For sanitary purposes the disease, excepting the pneumonic form, can be regarded as non-contagious. For its transmission an intermediate host for the bacillus is necessary and this is provided by blood-sucking insects. The commonest insect is the rat flea (see section 228), but the bed bug has been found to contain *B. pestis* and possibly any blood-sucking parasite can transfer infection from man to man. The likelihood, however, of the transmission of human plague by bugs, biting under natural conditions, is small.

The grey rat *Mus norvegicus* appears to be chiefly affected and the particular variety of flea principally concerned prefers this variety of rat. Fleas, however, will not remain on a dead body and so they migrate, when a rat dies, to the nearest host which may be the black rat *Mus rattus*. The latter rat is the one most commonly associated with man. After this rat becomes infected and dies, the fleas then desert and may be driven to attack man in search of food.

The bacillus grows in the stomach of the flea and, by multiplication, occludes the alimentary canal at the entrance to the stomach. Fleas in this condition are not prevented from sucking blood as the pump is in the pharynx, but they only succeed in distending an already obstructed œsophagus, and on cessation of the pumping act, some of the blood, along with bacilli, is forced back into the wound (See also section 230.)

Cold weather diminishes the incidence of plague because fleas flourish only in warmth. A moderate temperature with high humidity favours plague.

354. Symptoms.—There are four forms of plague, *i.e.*, Pestis minor, bubonic plague, septicæmic plague and pneumonic plague.

Pestis minor is important as cases are ambulatory and so are liable to be easily missed. The disease may then be widely spread. When there is any suspicion, a vesicle or pustule, which may occur at the site of infection, should be sought for and, if found, examined bacteriologically. The illness and symptoms are mild. Such cases are few.

Bubonic plague.—In this condition the patient is very ill. Buboes or hard enlargements of the glands occur, and are usually situated in the groin or axilla. Later on, the buboes break down and discharge.

Septicæmic plague has no characteristic symptom. It arises by extension of the bacilli from the lymphatics into the blood stream.

Pneumonic plague.—The presence of desperate illness, evidently pulmonary, with relatively few signs and profuse watery blood-tinged sputum unlike the rusty sputum of pneumonia, is strongly suggestive. A sudden acute epidemic of fatal pneumonia should invariably arouse suspicion of plague.

355. **Diagnosis.**—The importance of early diagnosis cannot be over-estimated and whenever the slightest suspicion of plague arises, laboratory examinations should be made.

In pestis minor, smears should be made from any vesicle or pustule and, if necessary, of gland juice obtained by plunging a hypodermic needle into any suspicious glandular swelling. Similarly in bubonic plague gland juice should be examined. The bacilli are very easily stained with Lœffler's methylene blue or dilute (1 in 10) Carbol fuchsin, when they are seen as bi-polar bodies. Another good stain is Carbol-thionin blue applied strong for 20-30 seconds and washed off with water. It should be noted that broken-down buboes may not give bacilli in smears, otherwise plague is almost the only bacterial disease in which the organism is found easily by this method.

In pneumonic plague, on staining smears of the sputum, abundant bi-polar bacilli will be seen.

Finally, it should be remembered that mixed cases of plague and relapsing fever occur.

356. **Treatment.**—This is largely symtomatic. For the use of anti-plague serum, see section 423.

Prophylaxis.

357. **Personal.**—The distinction between pneumonic and other forms of plague may here be borne in mind. In the pneumonic form the disease is intensely contagious from the patient's sputum, which is constantly being expectorated as fine particles during coughing, and thus infects the air of the room. In the other varieties transmission is entirely by the flea (or other insect). In any case patients must at once be strictly isolated and all contacts rigidly quarantined. The patient's bed, bedding, clothing and other material which could harbour the flea, should be

destroyed or disinfected and every means taken to free his person from all fleas, lice, pediculi, e c.

All attendants should wear puttees or gum boots, leather or rubber gauntlet gloves and overalls. The use of pesterine both for the patient and attendants is advisable. This is made by dissolving 1 part of soft soap in 5 parts of hot water and then gradually stirring in 20 parts of warmed kerosene. It should be applied freely. In clases of pneumonic plague, in addition, a complete mask for the face is essential. An anti-gas mask would usefully serve this purpose.

The clothing, bedding, etc., of contacts must be thoroughly disinfected and quarantine strictly maintained for 10 days, during which period the contacts should be rendered entirely vermin-free.

Convalescent patients must be isolated for one month.

Anti-plague inoculation to protect the community is now used with definite success. Two principal forms are Haffkine's vaccine and Yersin's serum, the latter being used only for curative purposes and then is of doubtful value (see section 424).

358. General.—The question of plague prevention is too large a one to discuss here fully. Briefly it may be said that measures depend on the following :—

(a) Knowledge of plague endemicity and the seasons of outbreaks.

(b) Special construction of dwellings, granaries, go-downs, etc.

(c) Early notification of rat epidemics.

(d) Destruction of rats by traps, poisons, etc.

(e) Avoidance of dead rats and their careful disinfection.

(f) Early detection of the disease in man, in particular the pneumonic form.

h) Isolation of the sick and strict segregation of suspected cases probably infected from the same source.

(i) Preventive inoculation.

Anti-rat measures.

359. When an epizootic of plague among rats is suspected, dead rats found should be examined for evidence of plague. To prevent

personal infection, great care must be exercised in collecting dead rats, as it is after death that the fleas quit their host and seek a new one. Therefore on approaching a dead rat, the ground around the latter should be drenched with 5 per cent. cresol solution or other disinfectant thrown from a bucket, and then the rat should be picked up with tongs, pitchfork or other implement. Place then in another bucket of disinfectant and press down below the surface. After a few minutes it can be removed and examined.

360. Post-mortem signs of plague in a rat.—The following are the most characteristic signs :—

(i) *Cutaneous.*—Sub-cutaneous congestion (pink skin and toes), oedema, sub-cutaneous hæmorrhages of various sizes, sometimes quite minute (? flea-bites).

(ii) *Lymphatic system.*—*Buboes*—hard, caseous centre, matted, surrounded by hæmorrhages and œdema. Situations: sub-maxilliary and cervical, inguinal, axillary, posterior-axillary, pelvic.

(iii) *Abdominal.*—*Spleen*—enlarged, moulded, may be congested, covered with minute white necrotic specks. If rat dies in later stage, or if recently recovered from acute attack there may be small splenic abscesses (with virulent B pestis in pus), also signs of recent perisplenitis, and adhesions of spleen to viscera and abdominal wall.

Liver.—Hard, moulded, waxy surface (as if covered with thin film of oil or grease, not water), very friable, granular, covered with minute necrotic specks. (Very characteristic).

(iv) *Thoracic.*—*Lungs*—pleural effusion (very common and very suggestive), minute pulmonary abscesses (very rare). *Heart*—Pericardial effusion, congestion.

(v) *Bacteriological test.*—*B. pestis.*—Present in spleen, liver, heart blood, bubo, etc. If there is much decomposition, heart blood and bubo may remain free from putrefactive organisms longest. B. pestis must be distinguished from pseudo-tubercle, chicken-cholera, hog-cholera and a few others.

On Agar, growth is slow and is translucent, slimy and sticky, the film being even and like ground glass.

On Broth, when grown for over ten days and not disturbed by the slightest vibration, stalactites will be seen This is almost diagnostic of plague but is also given by pseudo-tubercle.

(vi) *Biological test.*—The most certain test for the presence of B pestis in a putrid rat, in which plague otherwise could not be recognized, is by rubbing a little of the rat tissue (spleen or blood or bubo, etc.) into a small roughly shaved and bleeding surface of the abdomen of a guinea-pig. The guinea-pig dies of plague in 3 or 4 days as a rule.

NOTE.—The above is a *classical picture* and all signs are rarely present simultaneously. As a rule only 2 or 3 of the above signs are distinctly present at the same time, but when present they are a more certain means of diagnosis than a mere miscroscopic examination, especially in a semi-putrid rat. With a little practice, it should be possible to detect a plague-infected rat when the appliances of a laboratory are not available.

Negative signs—The only signs that may contra-indicate the presence of plague are:—

(1) A small, tough, flabby spleen.

(2) A small, tough, flabby liver.

(3) Healthy appearance of pleura and pericardium.

Where these are present, the rat has *probably* not died of plague.

Summary of emergent anti-plague measures and instructions for making and laying Poison Baits for Rats.

361. (i) *Origin of Infection of the first cases reported in an uninfected area.*—The incubation period of bubonic plague is 1 to 14 days (usually 3—5), and the infected rat flea may have remained alive 4 or 5 days previously. Therefore trace origin of infection, if possible, to some known epizootic area within the period of the past 3 weeks, or inquire for other suspicious cases of rat mortality which would indicate a new epizootic area—Classify a case accordingly as *Imported* or *Indigenous.*

(ii) *Outline of Action to be taken.*—When presence is established— or even suspected of an *epizootic* of plague amongst rats

in a hitherto uninfected area—notify it, and take action immediately on two distinct lines :—(*a*) and (*b*)—

(*a*) *Protection of individuals*—immediately exposed to infected rat-fleas (*i*) by *evacuation*—the best and most certain (*ii*) by *inoculation*, (*iii*) by *protection from infected fleas*—and what is synonymous, recently dead plague rats.

(*b*) *Protection of the community*—by checking the spread of the epizootic—chiefly by means of rat destruction. NOTE.—The epizootic spreads by three methods :—(*i*) by direct contiguity, like an ulcer ; (*ii*) by the formation of new foci, *i.e.*, fleas (rarely rats) conveyed to a distance in luggage or clothing ; (*iii*) by an entire epizootic amongst rats on a ship. Take suitable action against each.

(iii) *General Principles of Rat Destruction*—Poison baits are by far the most convenient and economical, and probably also the most effective means of bringing about a rapid reduction in the rat population.

Traps, when available, should also be set. They vary greatly in efficiency—an excellent pattern is the *Wonder Trap* (French pattern), but, of whatever make, the flaps should be operated by a light counterpoised weight and not by a spring. They are more suitable (when used continuously and properly set and, baited 2 or 3 times a week) for keeping the rat population reduced when once this has been effected by the use of rat poison.

Rat destruction for checking the epizootic.—Although, in its early stages, an epizootic area is comparatively limited and circumscribed and spreads only very slowly in all directions, nevertheless infection will always have extended considerably further than the occurrence of the last human cases or plague rats would appear to indicate. Therefore, in order to check the spread of an epizootic focus, always lay baits at least 200 or 300 yards (and in open spaces up to 500 yards) *beyond the spreading edge* of the epizootic area.

Rat destruction in anticipation of infection.—The above deals with infection at its source ; certain uninfected places might also be baited, in the same way, in anticipation of their becoming infected, *e.g.*, (*a*) where infected fleas may have been imported in luggage or clothing (*e.g.*, where an *imported* plague case has been living—see heading (1), (*b*) if locality be highly rat infected, (*c*) if extensive trade with infected area or place of pilgrimage,

(*d*) places which for other reasons it might be desirable especially to protect

Rat destruction in anticipation of infection by the "Clayton Process" or by baiting, is specially applicable to ships, "river-boats," barges, etc., before these leave an infected port for an uninfected one. When an epizootic on a ship is known to exist, landing cargo in rat-infested places will almost invariably lead to infection of the port Therefore in such cases land cargo, if possible, only in an isolated and rat-free locality, specially set aside previously for the purpose. Bait the area round this as a special precaution.

Rat destruction for the eradication of infection—In dealing with an epizootic, one baiting is not sufficient, but this should be continued in an infected area at intervals of about a week, till a full month has elapsed since the last case has occurred or plague rat found in that area In the off-season (differing in different parts of the country), infection, especially if *recently* commenced in a *large* rat-infested town, sometimes persists till the following plague season, *i.e.*, for three months or more, without shewing a single case of plague rat in the interval. In such instances, baiting should be continued *throughout* the whole period, for at that season alone (with nature's assistance) is there any chance of completely eradicating plague infection by artificial means.

(iv) *Poison Baits.—Material for Baits.*—The best composition for *Mus rattus* has been found (after considerable research in India, which is as yet incomplete) to be as follows:—

For 2,400 Baits —

Barium Carbonate [no other Barium salt] .	1 lb.
Flour made from the grain which constitutes the staple food of the locality . . .	3 lbs.

Mix poison and flour thoroughly, and then make into a stiff paste with water. Divide the mass, into about 2,400 baits, each the size of a hazel nut and roll into pill form Clean hands and dishes are necessary to avoid imparting extraneous taste and odour to the baits, which may diminish their attractiveness. The baits should be made fresh daily. The addition of such substances as meat, fish, cheese, sugar, fats, condiments or salt as a flavouring to dough made of flour or water, does not in any way render the mixture more palatable and attractive to the rat.

Substitutes.—The composition of these baits should not be changed without good reason: but two ounces of arsenic may be substituted for 1 lb. of barium carbonate.

Preparation and laying of Baits.—This should be carried out systematically and with *great care*, beyond the reach of children or domestic animals. For the initial baiting use a proportion of from 15 to 20 baits for a room the size of an E. P. tent and from 5 to 10 for subsequent baitings. In addition, bait gardens and compounds where rats are likely to be found, particularly just above high water mark on rivers and creeks.

At the time of baiting close all sources of food supply of the rat as far as possible, and then lay baits principally in all places associated with the food or water supply, of man, *i e.*, where food is stored, cooked, eaten or thrown away and where water is obtained, or where it is used for washing or irrigation purposes.

(v) *Flea Destruction.*—In addition to the above, infection may be prevented from being conveyed to new, uninfected areas by flea destruction.

Before removing kit or merchandise from an infected to a plague-free area, always open and spread in mid-day sun (if a temperature of over 120°F.) for one hour and failing that, put in a box (rendered fairly air-tight with paper and paste) in an atmosphere saturated with petrol vapour. Kits do not remain infected indefinitely. If no rats are present, infected fleas will probably not live more than 5 or 6 days, and in hot weather barely one or two days without food

(vi) *Note in Conclusion.*—(*a*) Conditions, climatic or otherwise, influencing the spread of plague, vary so greatly at different seasons of the year and in different localities, that measures which might be unnecessarily stringent on some occasions would be quite inadequate on others. Considerable judgment and discretion should therefore always be used in dealing with each case.

(*b*) That attempting to check the spread of an epizootic in its early stage by immediate rat destruction is the most important and urgent of all anti-plague measures.

(*c*) For rat destruction the liberal and systematic use of poison baits is probably the best means of bringing about a *rapid* reduction in the rat population.

(*d*) That infection amongst the rats will probably have spread considerably beyond the area in which plague rats and human cases have already been found.

(*e*) That infection amongst the rats persists for several weeks (in the off-season perhaps for 2 or 3 months) after the last plague rats or human cases have occurred. In carrying out rat destruction operations with the view of eradicating infection, it is all important that these points and particularly the latter (iv) and (v) should always be borne in mind.

Pyorrhœa Alveolaris, etc.

362. Affections of the teeth and gums are the cause of a considerable amount of disability among soldiers. There are three principle conditions to which preventive measures should be directed; *i.e.*—

Dental caries.

Pyorrhœa alveolaris.

Tartar.

The above is probably the order of their importance in relation to efficiency.

363. Dental caries.—This is an extremely common condition among European soldiers and is not infrequent among Indians. Where it occurs it often leads to loss of teeth through extractions. Simple caries of the teeth seems to be of little consequence in itself and is not proved to be a cause of dyspepsia, anæmia, or other troubles. Loss of teeth is also of little account up to a certain point.

As a general statement it may be said that so long as 4 pairs of teeth oppose each other, no ill effects seem to follow, and that where fewer teeth oppose than this, artificial dentures are indicated; each case must, however, be dealt with separately and the decision naturally rests with the dental surgeon.

Dental caries causes inefficiency when it gives rise to toothache and alveolar abscesses. The former leads to loss of sleep and frequently also to dyspepsia through the hurried eating of food. In either of these cases on field service it is best to extract the tooth. This especially applies in the case of alveolar abscess and there are no grounds for the superstition that a tooth should not be extracted whilst a swelling or abscess exists.

364. Pyorrhœa alveolaris.—This name indicates an advanced stage of chronic gingivitis which starts marginally Later, the gum separates from the tooth and leaves pockets, which become septic and exude pus The causative organism is not definitely known but appears to be most probably a leptothrix which throws off fusiform bodies similar to and perhaps identical with Vincent's organism. Frequently a spirochæte is also found. It is worth noting that an amœba, *Entamœba gingivalis*, has been found in some cases and, in association with this, there has been found in the fæces a small form closely resembling *Entomœba minuta* which may give rise to an erroneous diagnosis of dysentery.[23]

Pyorrhœa alveolaris may cause teeth to be lost as the result of separation of the gums and loss of vitality of the tooth. Tenderness of the gums and looseness of teeth induce bolting of food and give rise to dyspepsia. There is some evidence that rheumatism is caused by this disease, whilst anæmia, debility and many other conditions have been attributed to it [24]

365. Tartar.—This is a calcareous deposit which forms on the teeth at the edge of the gums and by its accumulation separates the gum from the teeth This leads to looseness, tenderness and eventual loss of the tooth Tartar is caused by the growth at the edge of the gum of a leptothrix in whose branching network the calcareous matter is deposited.

Prophylaxis.

366. From the above descriptions it will be seen that the prophylaxis of these conditions is summed up in keeping the mouth free from all septic foci. Decaying food must not be allowed to collect between and around the teeth. Men should be encouraged to clean their teeth frequently; after meals is the correct time and more particularly after the last meal of the day. Spaces between the teeth can be cleared of food debris by inserting cotton or silk thread, the folded edge of a piece of paper, or tape, and gently drawing to and fro. Rubbing the gums and teeth with the finger and salt is probably more efficient than using a tooth-brush as pockets in the gums are massaged and a healthy circulation stimulated.

Carious teeth should be filled or extracted and attention should be paid to all this at camps and depots *before* the men go on active service.

Rabies.

367. Rabies will be common in practically any area occupied by the Army in the field. All dogs, therefore, in the vicinity of the troops ought, as far as it is possible, to be kept under supervision.

When a soldier has been bitten by a dog or jackal, Pasteur treatment is indicated when:—

(*a*) The dog is considered to have rabies.

(*b*) The dog is unknown and disappears after having bitten the man.

(*c*) The dog is killed or dies within 10 days after having bitten the man.

(*d*) In every case where the bite is by a jackal.

When possible, a dog which has bitten anyone should be kept under observation for 10 days and inspected at intervals by a veterinary officer. If towards the end of this period the dog dies or shows symptoms of rabies, there is still sufficient time to commence Pasteur treatment. If the dog is alive and in normal health on the 10th day, there is no danger of rabies and Pasteur treatment is not required.

368. Treatment.—Pasteur treatment as carried out in India lasts for 14 days, and it is recommended that each soldier receiving treatment should be granted 10 days' light duty after completion

At the first opportunity after being bitten by any dog or jackal, the man should present himself for treatment. Early treatment consists of cauterizing the wound by the ordinary methods, *e.g.*, pure carbolic acid, potassium permanganate, etc.

369. Dispatch to Institute.—In the event of a soldier being bitten and it is considered necessary to send him to the nearest Pasteur Institute (Kasauli, Shillong, Coonoor) the following procedure should be carried out.—

(*a*) Arrange with the R.T.O. concerned for the man to be despatched by fast train.

(*b*) Notify his departure by wire to the D.D.M.S.; Lines of Communication, stating the probable hour of departure and requesting that he be met by a responsible person on arrival.

370. **Rabies in the Dog.**—Rabies occurs in two forms, known as furious and dumb rabies. The former is characterized by great excitement, the latter by paralysis of the lower jaw or extremities, and the appearance of frothy saliva trickling from the mouth. These two forms, however, are not clearly defined. Other symptoms are:—swallowing sticks, stones, straw, etc., snapping and biting unprovoked, restlessness and a tendency to roam or to hide; but a rabid animal may continue to recognize its master. Fear of water is not necessarily a symptom of rabies and inability to swallow or lap food may not appear until late in the disease. Certain of these symptoms are present in other diseases, *e.g.*, distemper.

371. **Laboratory tests.**—The only positive laboratory proofs of the existence of rabies in a biting animal are those afforded by the animal inoculation test and the microscopic test (Negri bodies in the hippocampus major). The second test is usually employed In neither case does a negative finding entitle one to conclude that the biting animal was not rabid. The laboratory test is essentially intended for the improvement of statistics and is of little value in practice in determining whether treatment is necessary or not, although in an emergency it is safe to conclude that a dog which exhibited no signs of rabies and, on being killed, showed no Negri bodies, was not rabid

372. **Rules to be observed in dispatching specimens.**—Wash the head of the animal with an antiseptic. Expose the skull by incising and reflecting the skin and overlying muscle. Fracture the vault of the skull with a hammer and remove the pieces of bone by means of forceps and knife The membranes of the exposed brain are then cut through and the brain removed from its cavity. It should be damaged as little as possible and at the same time care should be taken to avoid any possible infection of the operator by the brain substance, especially through the eyes. Now divide the brain into its two hemispheres. If the operator is not prepared to proceed with the further dissection, he may simply place one half of the longitudinally-divided brain whole into a large bottle with cotton wool or tow placed at the *bottom*. The brain should not be wrapped in wool as this prevents penetration of the preservative fluid. Next fill up with Zenker's fluid (potassium bichromate 5 drams, perchloride of mercury 7 drams, glacial acetic acid 7 drams and water 20 ounces) or ordinary strong spirit, using at least ten times as much as the

volume of the brain. It is better, however, to send for examination the hippocampus major rather than the whole brain. To do this :—cut the top off one hemisphere by thin horizontal slices until the floor of the lateral ventricle is reached. Remove the hippocampus major which is evident as a very characteristic curved nucleus in the floor of the ventricle. Place in a small bottle fully filled with preservative fluid. Dispatch the specimen fully labelled and secured to the nearest Pasteur Institute. In the absence of the necessary instruments, the head of the animal may simply be cut off and packed in abundance of ice, but if the ice be insufficient, the brain is apt to arrive putrid, which renders any examination impossible. Instruments should be sterilized after use and the hands should be thoroughly washed afterwards in an antiseptic solution

Relapsing Fever.

373. This is a disease caused by a special spirochæte which circulates in the blood. Synonyms are :—febris recurrens, Tick fever. In India the causal organism is named *Spiroschaudinnia carteri* and its transmission is effected by lice. Relapsing fever occurs in many other parts of the world, in each case being due to a spirochæte which receives a different name and is probably a different organism. The transmitters of the disease certainly differ and are given as follows :—

In Europe by the louse (and bug possibly).

In Asia by the louse (and bug possibly).

In East and West Africa by the tick *Ornithodorus moubata.*

In America the transmitter is unknown.

In Persia by the tick (Ornithodorus species).

In the Indian variety lice have been definitely incriminated as transmitters. The bug has not definitely been proved to transmit the disease, but it is capable of retaining the spirochæte alive in its alimentary canal for from 4-7 days. It has been shown that it can transmit the infection to monkeys

The presence of the various spirochætes in the blood is not constant and the numbers vary in the different types of the disease. The infection in the European type is heavy, in the African type it is sparse and in the Indian type it fluctuates. *S. carteri* is found in the blood during an acute attack, becomes

more frequent as the crisis approaches and after this disappears. It is not seen during the apyrexial period.

Spirochætes can be demonstrated by the microscope (see section 326). They appear as wave-like or corkscrew spirals of varying size. Different species have different types and activities of movement. As a rule they are about $20 \times 0{\cdot}4$ microns.

The louse after biting an infected person is not infective until the fifth day and remains so until the fifteenth day, after which it loses its infectivity. Unlike the flea in plague or the mosquito in malaria, the infection is not in any of the excreta of the louse and therefore its actual bite does not cause infection. The organism is within the body cavity of the louse and infection is caused by the person bitten crushing the body of the louse in the operation of rubbing and scratching, and so rubbing the infective material into the skin.

374. Symptoms.—Briefly, there is an abrupt onset, giddiness, moist furred tongue and high fever lasting 5-6 days, a sharp crisis with rapid recovery, and then a relapse in about one week. One, two or three relapses may occur. Enlargement of the spleen and liver may occur, whilst the body and abdominal pains are often very severe. Hæmaturia is sometimes a puzzling symptom The disease is most likely during the first attack to be confused with malaria, but if routine blood examinations are made, the presence of the spirochæte determines the diagnosis at once. Plague or typhus may occasionally co-exist.

375. Treatment.—This, apart from symptomatic treatment, consists in the use of arsenical preparations. Arsenobenzol or similar preparation, 0·4 gramme, is given intravenously, diluted as in the treatment of syphilis. One full dose as a rule suffices unless there is a relapse. Galyl or Ludyl may be given in 4-7 grain doses.

Prophylaxis.

376. All cases should be cured with arsenobenzol or similar preparation. Patients must be isolated until vermin-free and their blood has been negative to spirochætes for 3 examinations at 8, 7 and 6 days' intervals. In epidemics the whole community, in particular men of Labour Corps and casual labourers, should be submitted to disinfestation. (See section 185.) Prophylaxis generally consists in the avoidance of lice and bugs, and their destruction.

Sandfly Fever.

377. A disease caused by a filterable virus and transmitted by the owl midge *Phlebotomus papatasii*. A synonym is papataci fever, but three-day fever and Phlebotomus fever may both be taken to be the same disease though slight differences are recorded.

The virus of the disease is present in the blood of a patient during the first 24 hours only. It has not been identified but will pass through a filter. It is transmitted by the bites of the *Phlebotomus papatasii* which does not become infective until 6-8 days after taking up the virus. The disease tends to be epidemic and one attack usually confers immunity.

378. Symptoms.—The disease is characterized by a short sharp fever of 3 days' duration, slow pulse, injection of the conjunctiva and considerable mental depression It is very like influenza but without the catarrhal symptoms. One or occasionally two relapses are not uncommon; they occur most frequently about the 10-12th day. One full dose of the liquid extract of opium (30 minims) at the onset is advised.

Prophylaxis.

379. Patients should at the onset of the illness be protected with fine mul-mul nets to prevent further infection of the sandfly population. Other prophylactic measures are discussed in sections 209-212.

Scurvy.

380. The correct diagnosis of this disease is important, and cases of pyorrhœa alveolaris and simple gingivitis should be returned as such, and not as scurvy. The more common signs of scurvy are —spongy and swollen gums, loose teeth, œdema of the extremities, hæmorrhages into the subcutaneous and muscular tissues and mucous membranes, cardiac palpitation, anæmia, and general weakness. The onset is insidious and the first cases in an epidemic are frequently diagnosed as rheumatism on account of the muscular pains.

381. Aetiology.—(See section 246.) The anti-scorbutic vitamine is much less widespread among foodstuffs and less stable than that of beri-beri, and is contained in fresh foods only, dessication destroying it. Milk contains several vitamines, some of which are destroyed at 100°C., while others are not destroyed until 120°C. is reached. (Note that 20 fluid ounces of fresh milk are

considered physiologically equivalent to 6 ounces of condensed or evaporated milk or 20 fluid ounces of sterilized milk, irrespective of the brand issued.)

Cabbage, when boiled at 100°C., loses about one half of its antiscorbutic value in 30-60 minutes; at 120°C. this property is entirely destroyed in one hour. No antiscorbutic vitamine survives the heat of sterilization to which tinned foods are subjected.

Prophylaxis and Treatment.

382. The issue of fresh vegetables and fresh meat in the dietary is essential. An abundant variety of vegetables can be obtained in India.

Dried fruits, *e.g.*, raisins, apricots, dates, figs, apples and currants have a low anti-scorbutic value. Uncrushed masur and mung dal, germinated before use, have been used on field service. Mung dal germinates more readily than masur dal and is more appreciated by patients. Furst of Christiana showed that the scurvy-protecting substance develops when grains germinate, and disappears again on drying. He suggested that a stock of dried grain should be kept on boardship for use on long voyages when no fresh vegetables are available; the grains might be allowed to germinate and then be added to the diet with a view to preventing scurvy. The same applies to expeditions where fresh vegetables are not available to troops. By adopting the above procedure, portability and a high available anti-scorbutic vitamine content in the diet are ensured. This method is preferable to using tinned and dried vegetables, fruits, etc., in which the anti-scorbutic property is probably *nil* in most cases. Peas, mung and masur dal and also a bean from Rangoon sprout well and quickly. These grains and others can be used for the purpose. The procedure is simple and may be conveniently carried out in a manner such as follows:—

(*a*) *Soaking.*—The grains should be placed in a clean sack; this is steeped in a trough or barrel full of clean water, and the grain stirred occasionally. The sack and barrel must be large enough to allow for the swelling of the grains to about three times their original size. Four to six hours is sufficient for soaking in a hot climate, as putrefaction is liable to occur if the grains are soaked longer.

(*b*) *Germination.*—The grains are lifted out of the water and spread out well between two layers of clean blankets. The

blankets must be kept moist in order to ensure germination. The grains should not be heaped up as this prevents the access of air which is essential for the process. In hot weather 18-21 hours is sufficient for germination, in cold weather a longer period will be necessary.

All articles used in this process should be clean. The above is a simple method suggested for use but modifications may be adopted for special conditions, the general principles being borne in mind.

Sprouted grains must be cooked at once as, if kept, they will lose their anti-scorbutic properties The time of cooking should not be prolonged beyond what is strictly necessary. Fifteen minutes fast boiling at 212°F. is sufficient to soften masur dal.

Biscuits containing 15 per cent. of the wheat germ are being manufactured and are under trial.

Smallpox.

383. This is prevalent in India among the natives. It has to be distinguished from varicella or chicken-pox.

The chief points to note are :—

(i) The severe prodromal stage in smallpox with headache, fever, vomiting, pains in the back, and erythematous rash especially around the pelvis (bathing-drawers area).

(ii) The rash in smallpox tends to commence on the exposed skin, i e, forehead and wrists, and the pocks are shotty to the feel at first, and gradually become vesicular and umbilicated.

(iii) The rash in smallpox tends to spread steadily whilst in chicken-pox the pocks tend to come in crops on successive days.

Diagnosis is often difficult and, until it is certain that the case is not chicken-pox, every precaution must be taken to treat the case as though it were smallpox.

When smallpox is diagnosed, strict isolation of patient, and quarantine of all contacts for 16 days must be made. Vaccination and re-vaccination must be made at once of all contacts immediate and remote.

384. Method of recording vaccination.—Record of vaccination, besides being entered in the appropriate space of the Medical

387. **Treatment.**—This is largely symptomatic. Recently, injections of colloidal sulphur have been used with success [26]

Prophylaxis.

388. The disease has occurred in the East and one attack does not confer immunity. Prophylactic measures are those directed against wetness of trenches, the extermination of lice and possibly the destruction of rats and mice.

Trench Foot.

(Frostbite.)

389. The better name for this condition is Trench Foot as, though the condition is associated with cold, many cases have occurred with the temperature well above freezing point.

The disease is now known to be an infection by a fungus which is normally present in the soil and which acquires pathogenicity for the tissues when their resistance is lowered by cold and damp. This fungus grows best at a temperature of 25° - 30°C. and gains entrance through small abrasions or cracks of the skin or through the matrices of the nails. The wearing of any constricting garment on the legs or feet, such as puttees which shrink when wetted, tight boots or bandages, interferes with the circulation as also does prolonged standing, and in these ways the effects of cold and wet are aggravated, but recent pathological research points to the fact that the essential changes are brought about by the infecting organism, and that if this is excluded, the effects produced by the above predisposing causes are transient. This organismal theory is further proved by the fact that nutritional conditions of the subjects do not alter the incidence nor do racial factors. Hillmen, like Gurkhas, who might be considered to be inured to cold, suffer equally with Sikhs.

The lesions vary from slight vasomotor reactions to severe gangrene both moist and dry, the former being less common The chief effect is on the blood vessels which microscopically are seen to be swollen, vacuolated and to contain deposits of fibrin. The lymphatics and tissues are also seen to contain copious deposits of fibrin.

390. **Symptoms.**—The onset is usually indicated by coldness and numbness of the feet. The toes and dorsum become insensitive,

Purple and creamy coloration, œdema, bullæ and ulcers follow. Anæsthesia becomes definite and is often of a 'stocking' or 'sock' form.

Patches of extreme hyperæsthesia may occur. The nerve reflexes are almost normal. The process is rather insidious and the patient may be quite unaware of the extent of the mischief until he takes off his boots and inspects his feet.

Tetanus is apt to occur as a complication and some of the most severe cases of tetanus have followed trench foot. Gangrene which is really an advanced stage is not very common.

391. **Treatment.**—Anti-tetanic serum should be given Where actual freezing has occurred, the best first aid is friction with snow or cold water, but return to a warm atmosphere must not be too soon. In the early stages the limb should be kept elevated; warm, dry, and carefully aseptic; gentle massage and active movements may be used a little later.

Recent treatment is based on the theory of causation by an infecting fungus and has given good results. The part is carefully cleansed by soapy water and alkaline or, preferably, borated and camphorated washes. Special care must be taken between the toes and around the nails. A piece of cotton wool may be used dipped in a mixture of Pulv. camph 1.1 gramme, Sod. borate 15 grammes and boiled water 1000 grammes.

Chalier recommends the following:—A block of paraffin wax is melted and poured into a foot-shaped vessel called a "haricot" which was carried in all French ambulances. When the paraffin is sufficiently cool, the patient's foot is plunged into the bath and at the same time a 1 per cent solution of cocaine is poured in in the proportion of 10 c.c. to 200 c.c. paraffin. More recently he has recommended that the paraffin should contain Menthol 2½ grammes to 1000 grammes paraffin. In this way a wax-like varnish is obtained covering the whole foot. A fresh application is made every 3-4 days.

Prophylaxis.

392. Every endeavour must be made to provide dry standing places in trenches by drainage, pumping, raising of the foot-level by brushwood or straw with boards on top. Prolonged standing in the cold or wet should be avoided and the warmth of the body must be kept up, as far as possible, by constant movement.

All tight-fitting garments for the legs and feet must be avoided, especially closely-rolled puttees. Boots should be at least two sizes too large and in that case 2 pairs of woollen socks may be worn. Regular inspection of the feet and foot drill should be carried out wherever conditions productive of trench foot occur Cleansing of the feet with soap followed by the use of borated, or preferably camphorated washes and massage may be performed regularly when considered advisable. Dressing the feet and legs with oils, *e.g.*, whale oil or grease or purified and camphorated suet has also been used prophylactically with useful results.

Alcohol should not be allowed on going out into the cold; it gives a sensation of warmth which is false. Its effect of dilating the superficial bloodvessels is a predisposing cause of frostbite On return from exposure to cold, the rum ration may be taken A spare pair of socks should be carried in the pocket for use as a change.

Typhus Fever.

393. An acute exanthematous infectious disease, the virus of which is suspected to be a protozoal organism.

The actual causative organism has not been definitely isolated, but facts point to its being a non-filterable organism called *Rickettsia prowazeki* and found in the bodies of lice.

The louse has been definitely proved to be the usual transmitter of the virus though the possibility of conveyance by other vermin is not yet excluded. After biting an infected person the louse does not become infectious until the 7th day and ceases to be infectious after the 10th day.[27]

The period of incubation in man, after being bitten by an infective louse, is 5-15 days, usually 12 days. From these facts the quarantine period should be 25 days, but 16 days is the usual period. The disease is more prevalent during cooler weather and therefore in the higher altitudes of India, as here individuals live in closer association, bathe less frequently, and so the facilities for the spread of lice are multiplied.

394. Symptoms.—The rash is either mulberry, *i.e.*, rose-pink spots with petechial and subcuticular mottling, or has a water-course appearance, *i.e.*, red channels running here and there and combining to form erythematous patches. It appears first about the loins and is often most marked on the back.

The typhus state soon develops, which is marked by extreme lethargy, the general appearance being that of alcoholic intoxication. Complications are broncho-pneumonia and parotitis arising from the septic mouth, and gangrene, especially of the feet The tongue is dry and black and sordes collect on the lips and gums.

Diagnosis may be aided by constricting a limb above a part where the skin is clear, as this often brings out the typical rash.

Mixed cases of typhus and relapsing fever occur and both are lice-borne.

39 . Treatment.—Mainly symptomatic. Morphine may be given where no albuminuria exists. Horse serum, normal and phenol-free, 1 c.c. daily has been used as a hypodermic injection. For specific serum treatment see section 431.

Prophylaxis.

396. This is chiefly directed towards the extermination of lice. (See sections 179 and 217.)

The patient.—Worn-out clothing and worthless garments of refugees, etc., should be burnt. Field Service clothing should be carefully disinfected in a Thresh or other disinfector. Bed and bedding must be thoroughly disinfected, the latter by boiling for 5 minutes where feasible, otherwise by steam. The patient's night garments should be changed frequently during the first few days and boiled, including the bed linen. His hair (head, axillæ and pubes) should be cut short or preferably shaved, and vermijelli and N.C.I. poweder mixed and applied.

Attendants should wear gum boots, gauntlet gloves, overalls and a close-fitting cap to protect the head. Where feasible, linen or cotton clothes only should be worn, as these can be boiled.

The patient can harbour the virus for 3 weeks after the temperature is normal. Isolation should continue for 4 weeks. Lice can live on clothing removed from the body for 9 days and the eggs for 5 weeks. The infection appears to be able to be transmitted from the louse to its eggs which, when hatched, may therefore be infectious.

REFERENCES.

[1] Tropical Disease Bulletin, Vol X, p. 181.

[2] Chick and Hume ; R. A. M. C. Journal, Vol. 29, p. 137.

[3] Medical Annual; 1918, p. 106; Military Surgeon; 1916, Vol. 39, p. 358.

[4] Stitt; Tropical Diseases. Castellani and Chalmers; Man of Trop Medicine.

[5] Glen. Liston: B M. A (Bombay Branch) Meeting, March 1917

[6] Mem. on some Medical Diseases in the Med. War Area, p. 7.

[7] Tropical Disease Bulletin, Vol. 8, p 510

[8] Indian Journal, Medical Research, Vol 5, No 4; p 567

[9] Sutherland; Lancet, Nov 1916, p 828.

[10] Gordon and Flack; B.M J. Vol 2, 1916, p. 673 R.A M C. Journal, Vol. 27, p. 92; Medical Research Com. Spec Report Series No. 3.

[11] Parkes; B M J 1917, Vol 1, p 262

[12] Glover; Medical Research Com. Report, No. 9, March 1918.

[13] *Cf.* F. S. Regs I, 46(5)

[14] Mem. on some Medical Diseases in the Med. War Area, p. 34.

[15] Medical Research Com Spec. Report, Series No 15, p. 16.

[16] Medical Research Com. Spec Report, No 15.

[17] Medical Research Com. Spec. Report, No 9.

[18] *Cf.* F. S Regs I, 60(3).

[19] Medical Research Com.; Report of the Chemical Warfare Med. Com No. 3.

[20] Medical Research Com.; Report of the Chemical Warfare Med. Com. No. 1.

[21] Medical Man. (War) India, 20(10).

[22] Mem. on some Medical Diseases in the Med. War Area, 1917, p. 146.

[23] Lancet, July 14, 1917, p 58.

[24] Indian Journal, Medical Research, Vol 3, p. 742.

[25] Arkwright and Duncan; B.M J. 21 Sept. 1918, p. 307.

[26] Comrie, Lancet, 30 June 1917, p. 991.

[27] Foulerton; R. A. M. C. Journal, Vol. 29, p 224

CHAPTER VIII.

INFECTIOUS DISEASES.

Rules and Regulations, Incubation and Segregation Periods, etc.

397. Infectious disease in stations, camps, etc., will be notified as in peace on A. F. A-35. This report is submitted to the A. D. M. S. through the S. M. O., on the occurrence of infectious disease, and furthermore will be used for notifying such additional diseases as may be ordered from time to time.

The A. D. M. S., or S. M. O in the absence of the former, will notify *important* infectious and other diseases daily by telegram, and will post a weekly summary of all infectious and other diseases mentioned, to Army Headquarters in the Field. The daily telegram consolidates the reports received on A. F. A-35, whilst the weekly return is compiled from the weekly statistical return received in manuscript from each Field Hospital. In the latter, admissions and deaths will be shown for each disease, and separately for British and Indians.

Certain diseases assume importance only when explosive in character or appearing in epidemic form, and become notifiable by the medical officer only in those events. Similarly, other diseases are not sufficiently important to be included in the daily telegram submitted by the S. M. O. or A D. M. S. to Army Headquarters. These exceptions are indicated in the accompanying table.

398. Table of notifiable diseases.

Disease.	By M.O. to S M.O.		By S. M. O. or A. D. M S. in daily wire to G. H. Q.
	On occurrence of each case.	Only if explosive or assuming epidemic form.	
Anthrax . . .	*	...	...
Beri-beri . . .	...	*	...

Disease.	By M.O. to S M.O.		By S. M O. or A D. M S in daily wire to G H. Q.
	On occurrence of each case.	Only if explosive or assuming epidemic form.	
Cerebro-spinal Fever .	*	...	*
Chickenpox . . .	*	...	*
Cholera . . .	*	...	*
Diphtheria . . .	*	...	*
Dysentery . . .	..	*	...
Effects of Heat . .	*	...	*
Enterica . . .	*	..	...
Epidemic Jaundice .	...	*	...
Influenza . . .	*	..	*
Kala Azar . . .	...	*	...
Leprosy . . .	...	*	...
Malaria . . .	...	*	...
Measles . . .	*	...	*
Mediterranean Fever .	*	...	...
Mumps	*	...	...
Oriental Sore . .	...	*	...
Plague	*	...	*
Pneumonia . . .	*	...	...
Relapsing Fever . .	*	...	*
Sandfly Fever . .	..	*	...
Scarlet Fever . .	*	...	*
Scurvy	...	*	...
Smallpox . . .	*	...	*
Trench Fever . .	.	*	...
Typhus . . .	*	...	*

329. In the absence of Army Form A-35, a manuscript form may be submitted by the medical officer as follows :—

Infectious disease notification form, for British and Indian troops and followers.

(1) Corps, Rank and Name of Patient, and how employed.
(2) Brigade.
(3) Division,

(4) Camp or Barrack.

(5) Disease.

(6) Date of onset.

(7) Suspected source of infection.

(8) Sanitary condition of camp or barracks and surroundings.

(9) What measures of disinfection, isolation, etc., adopted.

(10) Recent movements of patient, giving places and dates, etc.

(11) Dates of preventive inoculation, including vaccination when applicable.

(12) General remarks.

Place __________ __________ M. O.

Date __________ __________ Unit.

400. Contacts.—Contacts must be segregated by units concerned who will make their own arrangements. They will not be sent to Field Medical Units. In the event of the occurrence of a case of cerebro-spinal fever, contacts will be isolated as far as the exigencies of the service will permit and will not be released until the patient has been pronounced negative by bacteriological examination.

In the case of chickenpox, German measles and mumps, it will be sufficient if contacts are medically inspected daily for 16, 17, and 21 days, respectively.

The term ‘contact’ refers to persons who have been in close contact with the sick prior to and after diagnosis.

401. Infectious Disease Hospitals.—These, consisting of a section or sections of a British or Indian General Hospital or other medical unit, will be opened as necessary, and will usually be required at the Base, at main halting places on the Lines of Communication, and at railheads.

402. Co-operation with Civil Authority.—The S. M. O. should keep in touch with the Civil Authority. Cases of infectious disease detected amongst the civil population would be reported to him. On all ordinary matters verbal and direct communication is the most satisfactory, but in asking officially for returns, *e.g.*, registration of civil deaths, infectious disease notification,

etc., he will communicate through his Base or other Commandant. He should co-operate as far as possible in providing the civil medical authorities with calf lymph, vaccines, drugs, etc., in emergencies and times of epidemic disease.

403. **Regulations.**—The following are the regulations with regard to infectious disease:—

On the first indication of an outbreak of any epidemic disease the O. C. the medical units in which the cases are in the first instance received, will at once inform the Os. C. the units to which the men belong, also the A. D. M. S. of the Division to which they belong. In cases of cholera, plague and smallpox, these reports will be sent immediately on the occurrence of the first case. An inquiry will immediately be made by the D. A. D M. S. with a view to tracing the source of the disease, and to stopping its spread [1]

During the course of an epidemic full information of its progress will be given in weekly returns. Special reports will be submitted when necessary.[2]

Isolation and disinfection will be carried out as thoroughly as circumstances permit in all cases of infective disease. Excreta will, whenever possible, be destroyed by heat.[3]

The facilities for the spread of all communicable diseases most common on field service are greatly increased by overcrowding, the occupation of camps for long periods, and the re-occupation of camps used by other troops. It is therefore of the utmost importance that these should be avoided as far as is consistent with military necessities.[4]

Inquiries 'as to the existence of infectious diseases' should be made on entering civil districts, etc.[5]

REFERENCES.

[1] Medical Manual (War) India, 29(8).

[2] " " " " 29(9).

[3] " " " " 29(10).

[4] " " " " 29(13).

[5] F. S. Regs. I, 53.

4. Incubation and Segregation Periods, &c.

TABLE.

Disease.	Incubation period.	Date of illness on which the rash appears.	Begins to fade	Isolation or Segregation of patient	Quarantine of contacts.	Carriers
Ankylostomiasis	4-6 weeks	On feet at site of entrance of larvæ a few days after infection	2 weeks after infection		..	Stools to be examined until found free from worm or ova.
Anthrax	1-5 days	Pustule usually appears about 3rd day		Until wound is healthy and healing		
Chickenpox	11-19 days	1st day and 3 following days	About 4th day	Until all crusts and scales have disappeared Antiseptic bath 6 days	20 days (See Section 400)	
Cholera	A few hours to 10 days. Usually 3-6 days	..		To remain in isolation for 12 days or where bacteriological examinations can be made, until 3 successive daily examinations of stools after administration of cholagogue have been negative	7 days	Quarantine until stools found negative as in patients Usually 3-4 weeks
Cerebro-spinal Fever	Not definitely known About 7-10 days	During first week	Disappears gradually	3 weeks from beginning of convalescence and until two negative bacteriological examinations have been made.	Until two negative examinations of swab have been made	Quarantine until two negative examinations have been made.

TABLE—*contd.*

Disease	Incubation period.	Date of illness on which the rash appears.	Begins to fade.	Isolation or Segregation of patient.	Quarantine of contacts	Carriers
Dengue . .	2-5 days .	Initial-few hours Terminal 4-7 days	From few hours to 1-2 days	7 days . . .	..	..
Diphtheria .	2-10 days .		.	6 weeks or until 3 successive daily swabs have been negative each made not less than 12 hours after discontinuance of local antiseptic		Until 3 negative swabs obtained, as for patients
Dysentery—Amœbic .	3-12 weeks	.		Until, after course of emetine, negative examinations of stools have been obtained as follows :—one in the 1st week, one in 2nd week and four in 3rd week.	..	Quarantine after emetine treatment as for patients
Bacillary . .	2-7 days	..	.	Until examinations of stools and urine have been negative	.	Quarantine until examinations of stools and urine have been negative.
Enterica :—Typhoid, Paratyphoid A and B.	10-14 days, occasionally 3 weeks.	Spots come out about 6th day and recur for about 2 weeks	Each crop lasts about 2 days.	Until examinations of stools and urine have been negative	..	Quarantine until examinations of stools and urine have been negative.

German Measles	9-18 days	2nd-4th day	4th-7th day	10 days after appearance of rash	20 days. (see section 400)	
Glanders :— Acute	2-3 days	3-4 days	.	Isolate until convalescent	.	
Chronic	Indefinite	..		Ditto	.	
Hydrophobia, in man (see also Rabies)	6 days to 2 years, usually about 6 weeks	..	..		.	
Influenza	1-5 days	A rash may appear or 2nd-5th day	After about 3 days	As far as possible during illness		
Jaundice— Bacterial	10-20 days	Jaundice 3-6 days	2-4 weeks	As for enteric		As for enteric
Spirochætal	6-8 days	Jaundice 2-3 days		Until urine free from spirochætes, usually 6 weeks		
Kala Azar	2 or 3 weeks to several months	.	.	During illness	Until removed from infected houses and rendered vermin free	
Malaria— Quartan	About— 3 weeks	.		Until 3 negative blood examinations for the malarial parasite have been obtained, patients should be strictly guarded against mosquito bites		
Benign Tertian	2 weeks	.	.			
Malignant Tertian	8-12 days					

TABLE—*contd.*

Disease.	Incubation period.	Date of illness on which the rash appears.	Begins to fade.	Isolation or Segregation of patient.	Quarantine of contacts.	Carriers.
Mediterranean Fever	10-15 days	..	..	Until urine is free of organism	.	Until excreta are free of organism.
Measles . . .	10-14 days, usually 12.	Koplik's spots 1st day. Rash 4th day. Very infectious during catarrhal stage	5-7 days .	2 weeks after appearance of rash	16 days .	.
Mumps . .	14-23 days	..	Swellings last 2 weeks	As far as practicable whilst swelling lasts	Usually not practicable. 24 days (See Section 400)	.
Oriental Sore . .	About 2 months	..	Sore lasts about 1 year.	Sore itself to be carefully shielded Patient not isolated.		
Plague, Bubonic . .	2-8 days, rarely up to 15 days	Buboes appear at end of 1st 24 hours up to 3rd day.	Suppurate in about 1 week or gradually disappear	Until convalescent and at least for one month	10 days .	.
Rabies in the dog. (See also Hydrophobia).	3-6 weeks .	..	..	Dog destroyed if rabid ; shut up for 10 days if suspected Quarantine for dogs 6 weeks.	..	..

Relapsing Fever	5-10 days	..		Until 3 negative blood examinations at 8, 7, and 6 days interval have been obtained		
Sandfly Fever	3-6 days	..		Isolation in a sandfly net		.
Scarlet Fever	2-8 days	2nd day	5th day	6 weeks after disappearance of rash and until any discharges, *e.g.*, nasal or otorrhœal, have ceased 2 antiseptic baths before discharge	10 days	.
Smallpox	10-14 days	3rd or 4th day	9th or 10th day	Until all crusts and scales have disappeared 6 daily antiseptic baths before discharge	16 days	.
Typhus	5-14 days usually 12	5th day	11th day	4 weeks	16 days (see section 393)	
Trench Fever	Not definitely known 6-25 days.		.	..		..
Whooping Cough	7-19 days		..	Where feasible, 5 weeks	21 days	..
Yellow Fever	2-7 days	Jaundice 3rd-4th day	Gradually disappears	Patient to be kept in a mosquito net during first 3 days	.	..

CHAPTER IX.

VACCINES AND SERA.

405. Vaccines.—Vaccines are preparations used both in the prevention and treatment of diseases. They are prepared directly from the organisms which cause the disease, and contain either the (dead) bodies of the organism or the poisons (toxins) formed by the organism, *viz.*, endotoxins or exotoxins; or all three of these may be present. Examples are T. A. B. vaccine for Enterica, Tuberculin, etc.

They are usually simple suspensions of the organisms in 0·85 per cent. salt solution, or actual broth cultures which have been subjected to a sterilizing temperature or have had an antiseptic added to them, or both

Various modifications in the mode of preparation (sensitized, lipo-vaccine, de-toxicated vaccine, etc) exist for which claims are made that they are followed by less reaction, produce a more rapid immunizing effect or a more prolonged immunity.

All vaccines in general use in India are prepared in this country and are issued, as a rule, free from protein substances other than the contained organisms. For this reason it may be said that for all practical purposes they cannot give rise to the phenomenon known as *anaphylaxis;* they are, however, liable to cause reactions.

A reaction to a vaccine usually comes on from a few hours to a day or two after the inoculation, and occurs in three forms:—

(1) *Local reaction.*—In this there is pain, redness and swelling of greater or less degree at the site of inoculation.

(2) *Focal reaction.*—This is evidenced by increased exudation, or secretion, congestion, swelling, etc., in the diseased part.

(3) *General reaction.*—A rise of temperature, headache and general malaise, etc., occur.

One or all of these reactions may be present and should be watched for, as they influence the date and amount of a second dose, especially when vaccines are being given for curative purposes.

406. Sera.—Anti-sera are employed principally in the treatment of disease, but sometimes also in prevention. They are the sera of animals which have been infected naturally or artificially with the particular organism, and which as a consequence contain certain immune bodies—"antibodies," "antitoxins," etc. These latter are capable, when injected into the human body, of overcoming the organism against which they are prepared, or of neutralizing the toxin elaborated by that organism.

On account of the blood serum (a highly complex organic chemical compound) and not the antitoxins which they contain, antitoxic sera may cause *anaphylaxis* when administered a second time. but only if a certain period has elapsed after the first dose. This phenomenon does not occur the first time that serum is injected and there are certain precautions which can be taken to prevent its occurrence. (See Section 438.)

Plain horse serum, *i.e.*, without any specific antitoxic property is sometimes used therapeutically and similarly may produce anaphylaxis in a patient who is susceptible.

407. High-titre Sera.—These are anti-sera prepared by highly immunizing an animal, and which therefore contain the specific antibodies in great concentration They are used in bacteriological work for the rapid identification of organisms by agglutination, absorption, fixation of complement and other serological tests. Highly specific precipitin sera are used for the identification of blood stains, whilst special haemolytic sera are used in the Wassermann test for syphilis

Cerebro-spinal Fever.

408. Anti-meningococcic Serum.—That prepared after Flexner's method is principally used. It is a polyvalent serum prepared from many strains of the organism. It is usually supplied in phials of 15 c.c. or 30 c.c.

The usual dose is 30 c. c., administered intrathecally after lumbar puncture, but in cases where less than 30 c.c. of cerebro-spinal fluid is withdrawn, then the dose should be 5 c.c. less than the amount of fluid drawn off. The dose is repeated every day for four days and for longer if necessary, the operator being guided by general considerations and the state of the cerebro-spinal fluid: if the latter remains turbid, the continuance of treatment is indicated.[1]

The serum, immediately after the withdrawal of the cerebro-spinal fluid, is run by gravity into the spinal canal at a temperature of 98·4°F. For this purpose a sterilized funnel and tube are used, the former being raised not more than 18 inches. An anæsthetic, general or local, may be given but is usually not necessary. Serum may be given subcutaneously in cases showing general toxæmia.

409. Meningococcic Vaccine.—This vaccine is used for curative purposes, more especially in chronic cases. An autogenous vaccine is preferable but a stock polyvalent one may be used. The doses are 250, 500, 1,000, 1,500, and 2,000 millions, given every four days unless a reaction occurs. In this event the last dose given should be repeated and its effects watched before a larger dose is administered.[2]

The vaccine has also been used prophylactically in the presence of an epidemic.

Cholera.

410. Anti-cholera Serum.—The value of this serum for curative purposes may be said to be still under trial. It is given in doses of 50 c.c. intravenously.

411. Cholera Vaccine.—This vaccine as prepared in India contains approximately 8,000 million vibrios per c.c. No beef is used in the preparation of the media employed for cultivation of the micro-organisms. Capsules require, before use, thorough shaking to ensure complete emulsification. Prophylactic inoculation is carried out by inoculation of two doses, *i.e.*, $\frac{1}{2}$ c.c. followed by 1 c.c. ten days later. The local reaction is moderate but the general reaction, which is usually severer after the first than the second dose, is however generally slight, the temperature rarely reaching 102°F.

Where debility or bowel affections exist, *full* doses should not be employed but three modified doses, *e.g.*, $\frac{1}{4}$ c.c.; $\frac{1}{2}$ c.c.; and $\frac{3}{4}$ c.c. at intervals of 8-10 days. The immunity produced is at its maximum for 4 months and remains to a lesser degree up to 6 months or more. For this reason cholera inoculations should be carried out just prior to the cholera season, which in India becomes prominent in April, reaches a maximum in July-August and almost ceases in November. Where cholera is anticipated or an epidemic exists, as the negative phase may be held to be negligible, troops should be inoculated at once, and the inoculations repeated, if necessary, after 4 months.[3]

Diphtheria.

412. Anti-diphtheritic Serum.—*Curative use.*—In all cases of diphtheria this serum should be used. It should be given immediately the diagnosis is made or strongly suspected. The usual dose is from 4,000-8,000 units in ordinary cases which are seen early; but in severe cases or those seen late with marked membrane or great swelling of the glands of the neck, the dose can be largely increased, *e.g.*, up to 20,000-24,000 units.

It is supplied in capsules of varying content but the number of units is marked on the label. Injection is made hypodermically over the abdomen or back.

413. Prophylactic use.—Small doses of from 500-2,000 units are sometimes given as a prophylactic measure amongst known or suspected contacts.

Dysentery, bacillary.

414. Anti-dysenteric Serum.—This serum is largely used in treatment and appears to be most reliable. The serum is usually polyvalent, prepared against the Shiga, Flexner and Hiss varieties of the *B. dysenteriae.* Several makers place preparations on the market: that manufactured by the Lister Institute is preferable.

The usual dose is 40 c.c. given hypodermically. In severe cases 100 c.c. may be given at once intravenously and repeated the next day if necessary; or, if improvement has followed, hypodermic doses may be resorted to.[4] In cases of moderate severity, 40 c c. given subcutaneously on three successive days will usually suffice. As much as 400 c. c. of the serum have been given in bad cases and have been the apparent means of saving life [5]

415. Dysentery Vaccine.—Prophylactic vaccination is at present on trial, the results so far being promising.[6]

A new dysentery vaccine is also being issued in England from the Vaccine Department of the Royal Army Medical College, Millbank. The immunity is said to last for 3-6 months.

Dysentery vaccines may be sensitized with human serum when the reactions after inoculation are distinctly less.

Enterica Fevers.

416. Anti-serum treatment has not yet been found successful.

417. Vaccines.—*Prophylactic.*—The official preparation is known as T. A. B. indicating the constituents, *i.e.*, *B. typhosus*, *B. paratyphosus A.*, *and B. paratyphosus B* The strength issued in India is the same as that issued by the R. A M. College, Millbank, which is as follows —

	Million per c.c.
B. typhosus	1,000
B. paratyphosus A	750
B. paratyphosus B	750

The dose is ½ c c. followed by 1 c.c ten days later. The reactions, both local and general, tend in some instances to be quite severe, for which reason all men who have been inoculated should, except in cases of urgent necessity, be struck off all duties for 48 hours—extendible if necessary—immediately after inoculation and be instructed to remain quiet during this period. They should also be warned that the consumption of alcohol after inoculation and whilst the arm is swollen greatly increases the pain and discomfort. Temperatures up to 104°F. may be experienced.

In extremely hot weather and other debilitating influences, latent malaria and bowel complaints, at least three modified doses, *e.g.*, ¼ c.c. ; ½c.c. ; and ¾ c.c , should be given at intervals of 8-10 days. When it is impossible to give the two-dose system one full dose of 1 c.c. should always be given unless the modified system is employed or inoculation is contra-indicated entirely by debility, etc.

418. Combined T. A. B. and Cholera Inoculations.—In healthy individuals and under favourable conditions, cholera inoculations may be given so as to overlap with routine T. A. B. inoculations, provided the doses are properly interspersed. The first dose of the cholera vaccine should be given first, and when the reaction has totally subsided, the first dose of the T. A B. vaccine may be given. The second doses will follow at intervals of 10 days respectively.

419. Rules for inoculation and re-inoculation.

(*a*) Men who have never been inoculated against enteric fever should receive two doses of T A. B. vaccine, *i.e.*, ½ c.c. followed by 1 c.c. 10 days later.

(*b*) Men who have been inoculated with one or two doses of (old) Typhoid vaccine a year or more ago, should be re-inoculated with T. A. B. vaccine, two-dose system.

(*c*) Men whose last inoculation was performed with T. A. B. vaccine a year or more ago, should be re-inoculated with T. A. B. vaccine, two-dose system.

(*d*) Men whose first inoculation or re-inoculation was performed with a single dose of ½ c.c. T. A. B. vaccine six months or more ago, should be re-inoculated with T. A. B. vaccine, two-dose system.

(*e*) Men whose first inoculation or re-inoculation was performed with a single dose of 1 c.c. T. A. B. vaccine a year or more ago, should be re-inoculated with T A. B. vaccine, two-dose system.

(*f*) Men whose last inoculation was performed with 1 c c T. A. B. vaccine less than a year ago, need not be re-inoculated until a year's interval is completed.

(*g*) Men who have been inoculated with two doses of T. A. B vaccine within a year, similarly need not be re-inoculated until a year's interval is completed.[7]

420. **Therapeutic use.**—Specific stock or autogenous vaccines have been recommended for the treatment of.—

(*a*) Osteomyelitis secondary to typhoid fever,
(*b*) Typhoid fever, in doses of 100-500 million bacilli every 4 days[8]

Mediterranean (Malta or Undulant) Fever.

421. **Anti-melitensis Serum** has been used with some success.

422. **Vaccine.**—An autogenous vaccine gives the best results Doses of 5 million cocci, which may be given at intervals of 48 hours, can be given at any stage of the disease with apparent good effect Larger doses may be administered in very chronic cases More recently, sensitized vaccines have been used.

Plague.

423. **Anti-plague Serum.**—*Prophylactic use.*—Confers a brief immunity, lasting from 10 days to 2 weeks.[9]

Therapeutic use.—Serum must be given during the first day or two of the disease in doses of 50-100 c.c. or up to 250 c.c.

in severe cases. In the severest cases it is better given intravenously instead of by the usual hypodermic method. In septicæmic and pneumonic plague, serum has proved of no value

424. Vaccine.—That manufactured in India is a goat-broth carbolized emulsion of dead bacilli. Doses of 0·5-4 c.c. are used according to the age of the person, that for an adult being on the average 4 c.c. A severe general reaction usually follows and immunity is held to last for a period varying from a few months to a year. This vaccine is only used prophylactically.[9]

Pneumonia.

425. Anti-pneumococcic Serum.—The successful use of this serum has recently been reported.[10] Four types of pneumococcus exist and, for success, the serum used should be prepared against the particular type infecting the patient. Large intravenous injections should be started early and continued until the infection is definitely overcome

426. Vaccine.—The use of a polyvalent pneumococcic vaccine for both prophylactic and curative purposes has been recommended. In India pneumonia is extraordinarily prevalent in certain stations on the North-West Frontier in the winter months and the mortality rate is high Prophylactic inoculation is being carried out in these parts but it is too early to make any pronouncement as regards its efficacy. Instructions as regards dosage are issued with the phials.

Smallpox.

427. Vaccine Lymph.—This should as far as possible be kept in ice-chests both during transport and storage. To establish uniformity, the following directions for vaccinating should be adhered to —

(*a*) The skin is best sterilized by the use of spirit which is allowed to evaporate off.

(*b*) Four small spots of lymph are then put on the sterilized area of skin—either driven from the lymph-tube by slightly heating the sealed end, or transferred by a sterilized needle or other scarifier if larger capsules or phials of lymph are being used

(c) The superficial layers of the skin are then scratched with the scarifier through a drop of lymph. The scarification should be sufficiently light as to cause serum to exude, but not blood.

(d) The scarified spots are then allowed to dry. When vesicles appear, a simple dressing may be applied and the less the arm is used the more quickly the part will heal.

Snake-bite.

428. Antivenin.—That manufactured in India is a combined serum prepared from the venoms of the Cobra and Russell's Viper. It is supplied in 40 c.c. capsules.

Amongst the conclusions arrived at as regards treatment, the following should be noted :—[11]

(a) Apply a firm ligature immediately.

(b) Inject from 100-200 c.c. antivenin intravenously if the biting snake be suspected to have been a cobra or Russell's viper. If symptoms of venom intoxication come on, further and even larger injections of antivenin should be given intravenously.

If the bite is on a finger or toe, is seen immediately and is due to an undoubtedly poisonous snake, amputation also should be performed, when the dose of antivenin may be reduced to 50 c.c. Cobra bites demand a bigger dose than those of Russell's viper.

Tetanus.

429. Anti-tetanic Serum.—*Prophylactic use.*—For this purpose dose of 500 U. S. A. units is injected subcutaneously, immediately after receipt of a wound in localities where tetanus is a frequent complication. Failing this, the injection should be made as soon as the case comes under observation. The site selected should be some distance from the wound. This rule should apply not only to wounds received on the battlefield but also to abrasions, however small, especially those contaminated with soil. Its administration is repeated every 7 days until the wound is healthy.

The fact of inoculation in the field should be recorded by marking the letter T with an indelible pencil on the man's forehead, *and also* by entering the dose on the battlefield Specification

Tally A.B. 166 and the Field Medical Card A.F. W-3118. Officers commanding field medical units should satisfy themselves that they are in possession of sufficient antitoxin, syringes, etc.

500 units are contained in about 3 c.c. of horse serum and no trouble from anaphylaxis is likely to arise from this dose. Even if 1,500 units contained in 10 c.c. of serum are injected subcutaneously, no dangerous symptoms are likely to occur as the risk of anaphylaxis from repeated injections of serum is negligible if the injections are repeated within a week of each other.

In order to guard against a latent tetanus infection developing as the result of a secondary operation at the site of a wound, even though the latter has been healed for many months, a prophylactic injection of antitetanic serum should be given two days before the operation. This time is fixed as it takes 48 hours for the antitoxin to be absorbed when given subcutaneously.

The War Office Committee for the study of Tetanus have recommended that in cases of long-continued septic wounds, particularly those caused by shell or bomb, third and fourth injections at seven-day intervals should be given. These injections, will not destroy tetanus bacilli that may be in the wound but, by neutralizing the toxin, will tend to limit the disease to a local form.

430. **Curative use.**—The Committee recommended the following doses :—

Day.	Subcutaneous.	Intramuscular.	Intrathecal.
1st .	...	8,000	16,000
2nd .	...	8,000	16,000
3rd .	...	4,000	8,000
4th .	...	4,000	8,000
5th .	2,000	...	...
7th .	2,000	...	...
9th .	2,000	...	...

Typhus.

431. **Anti-toxic Serum.**—It may be mentioned that antitoxic serum prepared from horses and donkeys has been used with success in the treatment of cases. Doses of 10-20 c.c. are given subcutaneously every day up to the stage of defervescence.[12]

432. **Vaccine.**—A vaccine prepared from *B. typhi-exanthematicis* is claimed to have been successful as a prophylactic measure.

Period of use of Sera and Vaccines.

433. The following instructions should be noted by medical officers in the field and also officers in charge of Advanced and Base Medical Store Depôts

Sera.—Anti-tetanic serum may be used as follows —

(i) For 12 months beyond expiry date, with 10 per cent. addition to the dose

(ii) From 12 months to 18 months beyond expiry date, with 20 per cent addition to dose.

(iii) From 18 months to 2 years beyond expiry date, with 30 per cent. addition to dose.

(iv) After this period it should not be used.

Anti-diphtheritic serum may be used up to two years beyond expiry date with the same additions to the dose as in (i), (ii), and (iii) above.

Anti-dysenteric, Anti-gonococcic and *Anti-mengococcic Sera* may be used for one year beyond the date of expiry with 10 per cent addition to dose.

Other sera should not be used beyond the date of expiry. In all cases where no date of expiry is mentioned on the container, this may be taken as one year after date of manufacture or date of issue by the maker. Although in the case of these sera an extended period of use, usually accompanied by a proportional increase of dose, may be authorized, every effort should be made to ensure that they are used *before* the original date of expiry is reached

Vaccines.—All vaccines may be employed for two years from the date of manufacture, except those mentioned below, which should not be used for periods longer than those stated.

	Months from date of manufacture.
T. A. B Vaccine	6
Cholera Vaccine	6
Dysentery Sero-vaccine	6
Sensitized Streptococcic Vaccine	3
Gonococcic Vaccine	3
Plague Vaccine	18

Indents.

434. Indents for vaccines, sera, calf lymph etc., are in the first place made by Field Medical units on the Advanced or Base Depôts, Medical Stores. The latter will maintain stocks by addressing consolidated indents, after reference to the D. M. S. in the Field if necessary, direct to Army Headquarters, India and *not* to the laboratories concerned in manufacture.

Instructions for carrying-out routine vaccine inoculations.[13]

435. The first step in the operation of any inoculation is to sterilize the syringe and needle. A temperature higher than 160°C injures the plunger if made of rubber, and a temperature lower than 160°C is not so efficient in effecting sterilization. Needles should be sharp, clean and patent. If these points are attended to, work is greatly facilitated and the operation is much less painful. See that the syringe is airtight. Take up the vaccine bottle or phial. Note the number of the brew, number of bottle and dose to be used. Always examine for any cracks or flaws in the glass. By handling the bottle or phial in the same way that the index of a clinical thermometer is shaken down, leakage will be detected. Faulty bottles must invariably be rejected.

The bottle or phial should then be well shaken so as thoroughly to mix the sediment which consists of dead bacteria and is an essential part of the vaccine.

To open the bottle or phial, hold the neck in the flame, turning the bottle round all the time so as to sterilize every part of the neck. When the glass is heated sufficiently, jerk up a little of the fluid and the neck will crack. The tip may then be knocked off by a sharp blow from a pair of sterilized forceps.

Now take up the syringe, pass the point of the bottle or phial through the flame and fill up the syringe with the vaccine. Get rid of excess air by adjusting the piston. Note the graduation marks on the shaft of the piston and screw up the disc to give the required dose. The syringe is now ready to make the inoculation. The procedure in the case of rubber-capped bottles is to deposit a drop of pure lysol or carbolic acid upon the rubber and introduce the needle through it to fill the syringe.

Method of injecting the vaccine.

(*a*) *Choice of a site for the injection.*—With a view to diminishing the pain which is consequent upon serous effusion and

facilitating the absorption of this effusion, it is advisable to inoculate the back of the arm (preferably the left arm), at the level of the insertion of the deltoid muscle.

(b) *Method of making the injection.*—The simplest method is to pick up a thick fold of skin between the fingers and thumb and then pass the needle through the skin in a sloping direction more or less parallel to the surface, carefully avoiding big vessels and not penetrating the muscles, but taking care to enter the subcutaneous tissues. The dose should be injected slowly.

The skin should previously be sterilized with soap and water, alcohol, and the site of election painted over with Tincture of Iodine. If a series of men are being inoculated at the same time, and the sterilization of the skin be entrusted to an assistant, he must be under the supervision of the operator who, it must be understood, is personally responsible for every detail connected with the operation. Immediately after the inoculation when the needle is withdrawn, the wound should be again painted with Tincture of Iodine and *neither before nor after the operation should the site of the wound be fingered.*

If a series of inoculations is being made, the needle of the syringe should be sterilized between each operation. This should be done by dipping it momentarily in hot oil which is kept at hand at a temperature of 160°C. After this has been done and before the next inoculation, a drop or two of the vaccine should be ejected from the syringe to get rid of any oil within the needle. The disc is then re-adjusted for the next dose.

NOTE.

All bottles or phials which have once been opened and which have not been used up completely in one series of inoculations must be thrown away and never retained for the purpose of further inoculations at a later date. This also applies in the case of rubber-capped bottles when these are issued.

As the rejection of the unused remainder in an opened bottle involves considerable wastage, it is very necessary for operators to collect parties for vaccination and to avoid the treatment of single individuals or even two or three, where it is possible to bring together large numbers at one time.

Instructions for Recording Inoculations.[11]

436. On field service, records of vaccination and all prophylactic inoculations will be made in the case of officers in the 'Record of Services' Book A.B. 439, and in the case of British and Indian troops and Followers on the inside right-hand cover of A.B. 64 (British soldier's Pay Book), A.B. 64M. (Indian Soldier's Pay Book) and I.A.F. K-1157 (Follower's Service Book). These entries will be made as follows until such time as a special form is provided in these books:—

Two-dose system.

$\frac{\text{T.A.B.}}{2}$ (or Chol.).—The dates on which the first and second inoculations were given, the initials of the medical officer or officers carrying out the operation should be entered thus:—

$$\frac{\text{T.A.B.}}{2} \qquad \frac{\text{1-10-18 H.B.}}{\text{10-10-18 H.B.}}$$

One-dose system.

$\frac{\text{T.A.B.}}{1}$ (or Chol.).—The date on which the single inoculation of 1 c.c. was given, and the initials of the medical officer should be entered thus.—

$$\frac{\text{T.A.B.}}{1} \qquad \text{1-10-18 H.B.}$$

Where modified doses are given, this fact must be recorded thus:—

T.A.B.	$\frac{1}{4}$ c.c.	1-10-18	H.B.
	$\frac{1}{2}$ c.c.	8-10-18	H.B.
	$\frac{3}{4}$ c.c.	15-10-18	H.B.

Anaphylaxis.[15]

437. This word is used to express a supersensitive condition which is brought about in animals by the injection of foreign protein substances, such as serum. The animal is said to be sensitised by the initial injection. If after an incubation period of some ten days the animal is again injected with the same serum sudden collapse and death may occur.

A very small dose is able to sensitise an animal, but a very much larger amount is required in the second dose to bring about the symptoms of anaphylactic shock. In a guinea-pig 0·001 ccm. will sensitise, but it requires five ccm. or more for the second dose to produce fatal shock when given subcutaneously. If, however, the second injection is given intravenously as little as one-tenth of a ccm. may be sufficient to kill the animal.

It must be borne in mind that the number of units of antitoxin contained in the serum has nothing to do with this, *it is the proteins of the serum itself which cause the mischief.*

The quantity of serum, therefore, in this second injection and the route chosen—intravenously is the most dangerous—have a great influence on the occurrence of this phenomenon. What is the exact amount required in man is not known.

There does not appear to be any danger of anaphylactic shock from injections of tetanus antitoxin in the small prophylactic doses of 500 units given subcutaneously however often they are given. No one need be afraid of injecting the three ccm. of horse serum, which as a rule contains the 500 units, every seven days as recommended. If more than seven days have elapsed since the last injection—ten, fifteen, thirty or more—there is also no serious danger to be anticipated. If a serum of higher potency is used, then there will be still less danger, as less serum will be required.

It must, however, be admitted that there is some slight danger in the case of developed tetanus, when large doses are given intravenously or, though to a much less extent, when given intrathecally. This small risk would not, however, justify the physician in withholding serum treatment. But it should be kept in mind that large doses (20 ccm and upwards) given intravenously or intrathecally, may give rise to anaphylactic shock.

Intrathecal injections are not considered to be so dangerous as intravenous, since the serum cannot leak out as quickly from the spinal canal into the general circulation as when directly introduced into a vein The patient should in this way, by this slow leakage, become desensitised.

As the dose of anti-dysenteric serum is large, 20 to 100 ccm of horse serum, there is undoubtedly a danger of setting up anaphylactic symptoms, especially if introduced intravenously, in soldiers who have previously had an injection of horse serum.

438. **The prevention of Anaphylaxis.**—Every soldier who is about to have an intravenous or intrathecal injection of serum, should be assumed to have already received a dose of serum at some time or other, and therefore to be in a sensitised or anaphylactic condition.

If large doses must be given intravenously, then a small desensitising dose should first be given

It is well known that when horses are immunised against the meningococcus for the production of anti-meningococcic serum, it is dangerous to use intravenous injections. The animals become hypersensitive and not infrequently die after an injection. The same thing occurs when anti-streptococcic or anti-staphylococcic serum is used. If a small desensitising dose be given intravenously two hours before the big dose, there is usually no trouble

Now what is the best and most practical method of desensitising or inducing anti-anaphylaxis? As a matter of fact, we have not sufficient experience of desensitisation in man to lay down definite rules. One method, which has been proposed, is to dilute five ccm. of the serum with fifty ccm. of normal salt solution. Of this mixture, one ccm. is injected intravenously. This is followed four minutes later by three ccm., two minutes later by 10 ccm, and after another interval of two minutes by twenty-five ccm. Then in ten or fifteen minutes the full dose may be given either intravenously or intrathecally. In such a dangerous disease as tetanus, the danger of inducing anaphylactic symptoms must be faced. *Nothing should interfere with the prompt administration of antitoxin.*

The presence of the hypersensitive state and consequently the necessity of attempting complete desensitisation may be determined by means of the allergic reaction. This occurs in sensitised individuals when a small sub-epidermal or intradermal injection (0·4 ccm.) of the serum is given. In sensitive individuals such an injection results in the development, within five to thirty minutes, of a raised urticarial or hyperæmic area from one to five or more cm. in diameter. If after the lapse of forty minutes no reaction has occurred, the patient may be assumed not to be hypersensitive. If such a reaction does take place, desensitisation may be proceeded with in the manner indicated.

It is also of importance to inquire before giving large doses of serum as to whether the patient is peculiarly sensitive to horses.

There is a class of persons with this idiosyncrasy known as "Horse Asthmatics," who are seriously affected by the mere smell of a horse or stable.

439. Treatment of Anaphylactic shock.—Up to the present no method of treatment has been found to be reliable, but a few remarks on the principles which it is thought ought to underlie such treatment may not be considered out of place.

It may be laid down at the outset, that the condition of anaphylactic shock is characterised by symptoms which can be referred to the vagus and sympathetic nerves.

Bronchial asthma, sweating, pallor, diarrhœa, occasional heart block, are symptoms which occur and which may also be elicited by stimulation of the vagus.

Fall of blood pressure with congestion of the blood vessels in the splanchnic area is a marked symptom, and a similar condition may be produced by paralysis of the sympathetic system.

Atropine has the effect of paralysing the vagus and adrenalin of exciting the sympathetic system.

There is some clinical and experimental evidence in favour of the view that the asthma of anaphylactic shock may be relieved by atropine. The drug may be administered in normal saline by intravenous injection in doses of gr. 1/50 atropine sulphate.

Adrenalin should also be given intravenously when the pulse indicates a considerable fall of blood pressure, in doses of 5—8 minims of 1-1,000 adrenalin solution in 10 cc. of sterilised normal saline.

The 1-1,000 adrenalin solution is already sterilised by the presence of chloretone and should be added directly to the already boiled normal saline as it is destroyed by boiling.

When there is any reason to apprehend any danger of shock, a syringe, atropine and adrenalin, should be at hand in case of accidents.

The patients should be kept as warm as possible, and brandy may be given. The asthmatic spasm is relieved to some extent by a few whiffs of ether or the inhalation of stramonium cigarette fumes. *It cannot be too strongly emphasised that when re-injections are given they should be given very slowly.*

REFERENCES.

[1] Medical Annual, 1918, p. 130.

[2] B. M. J. 1916 (ii), p. 691.

[3] D. M. S. Circular No. 4-S, dated 12th December 1918

[4] B. M. J. 1917 (i), p. 46.

[5] Mem. on some Med. Dis. in the Med. War Area, p. 40.

[6] Græme Gibson, R.A.M.C., Journal, Vol. 28, p. 656.

[7] D. M. S. Circular No. 3-S, dated 12th December 1918.

[8] Medical Annual, 1918, p. 34, 575.

[9] Stitt. Tropical Diseases, p. 169.

[10] Medical Annual 1918, p. 421.

[11] Acton and Knowles, Ind. J. Med. Research, 1914, Vol. II, No. 1, p. 46-148, 1915, Vol. III, No. 2, p. 275-361.

[12] Nicolle and Blaizot, Medical Annual 1918, p. 580, Lancet, Nov. 1916, p. 950.

[13] D. M. S. No. 19962-1 (DMS-5), dated 29th October 1917.

[14] D. M. S. Circular No. 5-S, dated 12th December 1918.

[15] D. M. S. No. 17740-1 (DMS-5), dated 16th April 1917.

CHAPTER X.

LABORATORY SPECIMENS.

Notes on collecting and dispatching.

440. In making glass slide or cover glass preparations to send to a laboratory for examination, such as blood-films, smears of pus, etc., the first essential is to have a clean sterilized slide. The best method of cleaning slides is as follows.—Place the glass slide for some time in a mixture of concentrated sulphuric acid 6 parts, potassium bichromate 6 parts, and water 100 parts; then wash thoroughly in water and store in absolute alcohol. For use, the slide is dried by wiping with a clean duster or simply allowed to dry.

Where such a method is not available, a clean slide may be dipped in alcohol, then the alcohol is burnt off and finally the slide is polished with a clean soft rag or duster.

In either case it is essential that the surface of the glass be not touched by the fingers after the cleaning.

441. Blood-films.—A small drop of blood is taken on to a clean slide about ½ inch from one end and, with the fingers at each end, this slide is held at a slant, the drop being lowermost. A spreader of narrower dimension than the slide (this can be made from another slide by chipping off the corners) is then taken in the other hand and brought downwards to touch the drop of blood which at once spreads laterally to the limits of the spreader.

The slide is then slowly withdrawn downwards, maintaining contact with the spreader, when the blood will be spread in an even manner and should leave tongues reaching to within ½ inch of the other end of the slide. The film is then dried in the air. Then scratch with a needle the name or identification number on the middle of the film and finally wrap in clean paper so as to prevent flies settling and removing the blood.

The reason for a clear margin being present both at the sides and at each end, is to allow of all parts of the film being examined on a microscope fitted with a mechanical stage, whilst the method

of abstraction of the slide rather than propulsion of the spreader tends to lessen the number of broken cells in the resulting film.

442. **Thick Blood-films.**—Prick the finger; allow a fairly large drop of blood to exude and receive on the centre of a slide. Using the head of a needle, spread this drop over an area about one third of an inch square. The film should dry homogeneously; if it shows a tendency to flocculation, it is too thick.

Each slide must be wrapped up *separately* in a piece of paper with the name, number, rank and regiment of the patient, and the examination required written clearly on the paper.

443. **Blood Counts.**—For a *differential blood count*, a blood-film is taken as above.

For a *red* (erythrocyte) count and a *white* (leucocyte) count a hæmocytometer is necessary. There are two pipettes; the one narrower and of less capacity is used for the red count and the other which is wider, for the white count. Each has three graduating marks, *i.e.*, one half way up the stem, one just below the bulb, and one just above the bulb. In ordinary cases the 0·5 mark half way up the stem is used; the mark below the bulb only being used in cases of severe anæmia.

The finger or ear is cleaned and pricked with a sterilized needle. The first drop of blood is wiped away and then the blood is sucked up the pipette to the 0·5 mark, diluting fluid (Toison's for the red count and Hayem's for the white) is then sucked up to the mark above the bulb. The pipette is then gently rolled to and fro to mix the contents of the bulb The latter should then be blown out into a clean sterilized watch glass, re-drawn up into a pipette or capillary tube, and be prevented from evaporating by sealing both ends. When dispatching, enclose a paper stating, in addition to the name, etc., whether the blood was drawn up to the 0·5 or the 1·0 mark of the hæmocytometer pipette.

444. **Blood Cultures.**—Blood for bacteriological cultures is taken directly from a vein. It should be taken early, as in diseases such as enterica the organism is apt to disappear from the blood-stream. Absolute asepsis is here essential. A syringe of 5 c.c. or 10 c.c. capacity, with a needle having a good sharp point, is required. The needle and syringe, with its parts taken to pieces, are boiled and taken to the bedside in the sterilizer or, more simply, the syringe is sterilized by drawing up hot oil and

carried to the bedside in a sterile test-tube. The median basilic vein is usually chosen and the skin over it painted with tincture of iodine. A bandage is tied round the arm sufficiently tight to distend the vein. The vein may be brought out more by telling the patient to clench the fist once or twice. The operator, having sterilized his own hands, then puts the syringe and needle together, avoiding touching the pointed end of the needle. Steadying the arm with the left hand, he then plunges the needle obliquely into the vein. As soon as the needle is in the vein blood flows readily into the syringe. 5-10 c.c. of blood should be drawn up and the bandage on the arm then untied. The needle is withdrawn and finally a pad tied over the site of puncture.

The culture media must be ready at the bedside. Two to five c.c. of blood should then be inoculated into the culture media supplied (usually 20 c.c. of a 5 per cent. taurocholate of soda solution in a rubber-capped bottle) and the remainder may be used to fill sterile Widal tubes.

The syringe must then be washed out carefully to prevent blood-clot forming in the needle, sterilized, and the parts taken to pieces.

The cultures, etc., are then sent to the laboratory with full particulars.

445. Serum for Wassermann and Widal Tests.—Blood for these is usually obtained more satisfactorily from a vein as described for blood cultures. Wright's capsules, however, may be used but these require considerable practice to fill sufficiently for the test to be carried out. When obtained from the vein by a syringe, the blood should be transferred to a sterilized test tube and set aside for several hours to allow the serum to separate out from the clot. Then either fill a Wright's capsule or a pipette with as much serum as possible, seal—taking care not to heat the serum—and dispatch with full particulars. 1 c.c. of serum is sufficient for either of these tests.

446. Pus.—Pus should either be collected in a sterilized test tube or, if there is insufficient for this, a sterilized platinum needle can be used to make cultures and films (as in blood films) or, failing this, a swab of the pus may be taken as for diphtheria and sent to the laboratory in a sterilized test tube.

447. **Fæces.**—If the laboratory is in the immediate vicinity, fæces may be placed in small tins with well-fitting lids and the latter sealed with surgical strapping. When dispatched through the post, certain precautions are necessary. Firstly, as fæces that require examination are usually liquid, leakage in transit must be guarded against Fine sterilized sand should first be added until a consistency of thick paste is obtained. Secondly, in order to keep the temperature as low as possible, the tin containing the sample should be packed in moist tow, etc., and the whole put in a perforated box. Finally, the specimen should be delivered to the laboratory as early as possible; if the sample arrives within two days, enterica organisms should be as easily recovered by the ordinary plating method as from a fresh sample.[1]

448. **Urine.**—Urine should be collected in sterilized bottles, *e.g.*, medicine bottle, be tightly corked and sent as fresh as possible, labelled with the name, etc., and examination required. A catheter specimen is best for bacteriological examination, otherwise the meatus should be wiped with antiseptic, a small portion of the urine allowed to pass into an ordinary bottle, and the remainder collected in the sterilized bottle.

449. **Sputum.**—If the laboratory is near, the bedside spittoon may be sent, otherwise a small sterilized bottle, gallipot, etc., should be used. The disease suspected should be mentioned.

The sputum for examination should be definitely obtained from the lower respiratory passages The early morning sputum is the best. Saliva or pharyngeal exudate is frequently sent in mistake for sputum.

N.B.—In collecting the above specimens, *i.e.*, fæces, urine, sputum, it is essential that no antiseptic be used in the vessel.

450. **Cerebro-spinal Fluid.**—Collect directly from the needle or cannula into sterilized test tubes at the time of lumbar puncture. One or two ounces at least should be sent if obtainable, otherwise as much as possible. Cerebro-spinal fluid must be kept at body temperature, for which reason it is impracticable to dispatch by post. *Pleural, ascitic and cystic fluids* are collected in the same way as cerebro-spinal fluid. In each instance the culture tubes are best planted at the bedside.

451. **Swabs.**—Swabs are chiefly taken from the nose and throat in cases of diphtheria, cerebro-spinal fever, etc., but may be used

for pus, etc. They are made by wrapping a piece of cotton wool round the end of a probe, thin stick, wire, etc. The cotton wool is rubbed gently on the selected surface and then placed in a sterilized test tube containing a cork. The cork should be luted with paraffin wax or sealing wax, to prevent evaporation. The test tube should be carefully packed to guard against breakage, and sent to the laboratory with full particulars. In cases of diphtheria where the faucial membrane is tough, it is advisable to push the swab under the edge of the membrane, as often a negative result is obtained when the surface only is swabbed. A film on a slide, made directly from another swab, should accompany the specimen. In cerebro-spinal carrier work the swab should be free from saliva and so should be guarded for post-nasal swabbing.

452. Tissues.—If the laboratory is near, portions of tissue for examination should be sent immediately in a sterilized vessel: if distant they should first be smeared on to glass slides to make film preparations, and other portions put into 70 per cent. alcohol or methylated spirit or Zenker's fluid (see Section 372) if sections are to be cut.

It is absolutely essential, if the histological examination is to be satisfactory, to send all particulars with the tissue regarding duration, ulceration, adherence, etc. The clinical facts suggesting malignancy or non-malignancy in the case of tumours should invariably accompany the specimen.

453. Insecta.—Mosquitoes, sandflies, fleas, bugs, etc., require careful handling both in catching and packing, to prevent damage to minute hairs or other distinguishing characteristics. Three methods of dispatching are given:—

(*a*) Pass a fine pin through the thorax until the insect is half way up the pin. Cut a circular disc of cardboard of slightly less diameter than the test tube to be used. Pin the insect through the cardboard disc to the base of a cork, burying only one quarter the length of the pin, invert and cork tightly in the test tube.

(*b*) Wrap in soft paper folded like a sugar bag.

(*c*) Tease out cotton wool into fine staple, make a nest in a pill box and insert the mosquito or sandfly. Pack the pill boxes in a larger box and add one or two drops of medical creosote to prevent moulds forming.

Full particulars with regard to locality in which caught, animal host, etc., should always be submitted.

N.B.—Pathological and other specimens are technically the property of the Government of India.

454. Precautions to be taken in posting.—The following extract from the Post Office Guide, India, shows the regulations in force regarding the dispatch by post of certain pathological specimens.[2]

Human and other viscera.—Human and other viscera may be transmitted by the Inland post to Chemical Examiners for analysis, subject to the following conditions.—

(*a*) The suspected viscus or other material to be sent for examination must be enclosed in a glass bottle or jar, fitted with a stopper or sound cork

(*b*) Great care must be taken that the stopper or cork of the bottle fits tightly. This precaution is especially necessary when alcohol is used as a preservative, in such cases a ring of bees' wax or candle-wax must be placed round the lip of the bottle so as to cover the shoulder of the stopper. The stopper must be carefully fastened down with bladder or leather and sealed.

(*c*) The glass bottle or jar must then be placed in a strong wooden or tin box, which must be large enough to allow of a layer of raw cotton, at least three-fourths of an inch thick, being placed between the bottle or jar and the box.

(*d*) The box itself must be encased in cloth, which must be securely closed and sealed. The seals must be at intervals not exceeding three inches along each seam. All the seals must be of the same kind of wax and must bear distinct impressions of the same device. The device must not be that of a current coin or merely a series of straight, curved or crossed lines.

455. *Plague Cultures.*—Cultures or other articles known or believed to contain the living germs of plague may be transmitted by the Inland post, subject to the following conditions.—

(*a*) Such cultures or other articles aforesaid must not be accepted for transmission, unless they are sent by a Commissioned Medical Officer, a Military Assistant Surgeon, or a Medical Practitioner in possession of a qualification not lower than that of L. M. S. of the University of Calcutta,

CHAPTER XI.

VITAL STATISTICS.

Stations on the Frontier and Lines of Communication.

456. The accompanying table has been compiled, where possible, for the quinquennial period immediately prior to the Great War, in order that conditions arising from overcrowding, constant movement of troops and excessive recruiting, etc., should be eliminated.

The ratios may help in estimating whether sickness is abnormal and therefore whether special reports should be made and prompt measures taken.

VITAL STATISTICS OF CERTAIN STATIONS ON THE FRONTIER AND LINES OF COMMUNICATION.

Ratio per 1,000—British and Indian Troops—Quinquennial Period 1910-1914.

N B.—Where the period is less than 5 years, figures in brackets after the station indicate the number of years observed.

STATION.		All causes	Cholera	Enteric Fever	Malaria	Sandfly Fever	Pyrexia of uncertain origin.	Pneumonia	Dysentery	Plague.	Smallpox	Average constantly sick
Ambala . . .	British	566.5		2.5	73.9	17.7	27.6	1.0	6.9		0.2	36.1
	Indian	592.0		1.2	126.0	38.9	21.0	6.0	13.2	0.1	0.4	17.9
Attock .	British	1041.8	1.7	5.2	230.0	219.5	54.0	3.5	7.0			32.8
(4)	Indian	1146.1	.		168.5	104.9	194.8	15.0	71.2			33.7
Bannu . .	Indian	767.5	0.7	2.5	244.3	25.0	31.3	15.3	30.0	0.1	0.1	21.8
Bhamo . . .	British	757.7	.	.	167.9	.	129.9	2.9	1.5			43.5
	Indian	694.4			234.8		47.0	3.1	6.9	1.4		24.5
Buxa Duar . .	Indian	440.5	.		119.0		19.3	7.4	1.5		1.5	20.8
Chakdara . .	Indian	790.3		3.0	184.2	.	97.6	9.7	20.6			22.4
Chaman . .	Indian	229.9	.	1.9	39.3	6.1	23.2	9.4	4.2			10.3
Cherat . .	British	696.7	.	2.1	167.1	15.0	16.3	1.7	4.2		.	25.4
	Indian	535.9		27.6	71.8	..	5.5	5.5	16.6		.	27.6
Chitral . .	Indian	1430.2		6.9	58.8	342.6	501.7	1.2	15.0			30.0
Dargai . . .	Indian	723.1		1.0	110.8	8.8	27.3	13.7	8.8		0.5	22.9
Dibrugarh .	Indian	668.4	..		154.3		44.8	14.7	12.4			25.9
Dera Ismail Khan .	Indian	1194.6	.	1.8	472.1	0.3	85.8	11.7	43.9		1.0	37.4
Drazinda . .	Indian	1023.6	..		331.1	.	74.3	6.8	175.7			27.0
Fort Abazai (4) .	Indian	821.9	..	3.5	234.6	7·1	82.9	10.6	10.6			19.4
Fort Jamrud . .	Indian	915.7		2.0	176.7		18.1	2.0	54.2			14·1
Fort Lockhart . .	Indian	669.1	0·6	3.6	208.8		24.1	7.3	20.7		0.6	22.4
Fort Sandeman .	Indian	709.3		0.4	231.5		4.6	10.6	9.7			25.3

Fort Shabkadr (4)	Indian	890·4	..	5 7	225·0	39 7	30 2	11 3	5 7		..	17 0
Fort Zam	Indian	1790 3	..	.	731 2	..	48 4	10 8	166 7	..	.	[illegible]
Gangtok	Indian	279 0	..	1·5	1 5	.	48 8	3 0	1 5		1·5	13·7
Gumbaz	Indian	503 8	.		251 9	..	7 6	.	22 9	..	.	[illegible]
Gyantse	Indian	407 1	.	3 6	17 9	.	71 4	7 1	..	.	..	[illegible]
Hangu	Indian	745 7	0 9	0 9	[illegible]	.	17 2	10 0	30 8	0 9	0 9	[illegible]
Hindubagh	Indian	753 2		.	[illegible]	.	6 5	6 5	32 5	..	.	[illegible]
Jandola	Indian	1646 1		1 5	[illegible]	1 5	257 5	25 6	116 0	..	..	[illegible]
J[illegible]a	Indian	823 7	.	3 4	[illegible]	..	78 0	13 6	84 7	..	.	[illegible]
Jhelum	Indian	723 [illegible]		2 0	[illegible]	0 1	73 0	11 5	24 2	..	0 5	[illegible]
Kila Drosh	Indian	1050 4		10 8	[illegible]	249 2	172 2	3 0	4 7	..	1 0	[illegible]
Killa Saifulla	Indian	697 4			[illegible]	.	13 2	6 6	111 8	.	..	[illegible]
Kohat	Indian	847 7	1 6	4 8	[illegible]	5 2	10 1	12 2	17 1	0 1	0 8	[illegible]
Kohima	Indian	1019 7	..	.	[illegible]		133 3	10 6	34 8	..	..	[illegible]
Lahore	British	897 4	0·9	4 7	[illegible]	11 9	71 7	3 9	12 5	.	0 4	10 4
	Indian	812 5	1 4	3 3	[illegible]	0 5	84 3	9 1	37 7	0 1	0 8	[illegible]
Loralai	Indian	787 4		1 4	[illegible]		184 4	7 1	10 6	.	..	[illegible]
Malakand	Indian	672 2	.	0 5	[illegible]	2 0	28 1	9 2	19 7	.	..	[illegible]
Manipur	Indian	693 6		0 4	[illegible]	.	32 7	8 4	19 0	.	0 4	[illegible]
Manzai	Indian	786·2	.		[illegible]	..	39 9	10 9	68 8	.	.	[illegible]
Mardan	Indian	590·7	0 2	0 2	[illegible]	3 1	20 7	22 4	5 8	..	0 7	[illegible]
Mir Ali Khel	Indian	[illegible]	..	..	[illegible]	..	25 4	14 5	10 9	.	..	[illegible]
Multan	British	[illegible]		2·3	[illegible]	20 0	72 1	4 9	3 8	.	..	[illegible]
	Indian	[illegible]	0·1	2 3	[illegible]	10 9	34 1	7 5	13 2	..	0 3	[illegible]
Murgha	Indian	[illegible]			[illegible]	..	62 1	6 2	31·1	..	.	[illegible]
Musa Khel	Indian	[illegible]		5 4	[illegible]		64 9	5 4	59 5	..	.	[illegible]
Nowshera	British	[illegible]	.	3 2	[illegible]	204 3	16 0	6 5	1 7	.	..	[illegible]
	Indian	[illegible]	0 4	1 5	[illegible]	22 7	14 6	10 7	11 9	0 2	0 6	20 4
Peshawar	British	[illegible]		3·1	[illegible]	264·3	30 9	4 0	3 3	.	.	[illegible]
	Indian	[illegible]	0 1	3·3	[illegible]	16·4	18·5	10·7	18·6	0 3	0 3	[illegible]
Pishin	Indian	[illegible]		..	[illegible]	50 8	22 6	15 1	13 2	.	.	[illegible]
Rawalpindi	British	[illegible]		3 8	[illegible]	69 6	29 3	3 1	3 2	.	0 1	[illegible]
	Indian	[illegible]	.	0 8	[illegible]	0 9	112 9	9 6	21 7	0 2	0 5	[illegible]
Robat	Indian	[illegible]	..	1 3	[illegible]	.	22 6	..	12 6	..	..	[illegible]
Sadiya	Indian	[illegible]	.		[illegible]	.	8·3	4 2	25 0	.	..	[illegible]
Sialkot	British	[illegible]	0 2	5 6	[illegible]	15 5	13 2	3 5	5 0	..		[illegible]
	Indian	[illegible]	0 9	4 2	[illegible]	0·7	22 8	7 8	13 2	0 6	0 5	[illegible]
Shelabagh	Indian	[illegible]	.	..	[illegible]	.	19 2		5·5	..	2 7	[illegible]
Shillong	Indian	[illegible]		5·8	[illegible]		36 7	12 1	19 7	..		[illegible]
Thal	Indian	[illegible]	..	1·5	[illegible]	4 4	10 2	7 3	58 3	..	.	[illegible]
Quetta	British	[illegible]		1 9	[illegible]	4·3	10 1	2 3	3 9	..	0 1	[illegible]
	Indian	[illegible]	0 1	3·0	[illegible]	0 4	37 7	7 6	5 9	..	0 2	[illegible]

CHAPTER XII.

USEFUL DATA.

Weights, Measures, etc.

457. Measures of Length.

				Metres.			
1 Myriametre	.	Mm	=	10,000	=	6·2137	miles.
1 Kilometre	.	Km	=	1,000	=	0·6214	mile.
1 Hectometre	.	Hm	=	100	=	109·361	yards.
1 Dekametre	.	Dm	=	10	=	32·8084	feet.
1 Metre .	.	M	=	1	=	39·370113	inches.
1 Decimetre	.	dm	=	0·1	=	3·937011	,,
1 Centimetre	.	cm	=	0·01	=	0·393701	,,
1 Millimetre	.	mm	=	0·001	=	0·039370	,,
1 Micron	.	μ	=	0·000001	=	0·000039	,,

458. Measures of Mass.

				Grammes.			
1 Myriagramme	.	Mgm	=	10,000	=	22·0461	pounds.
1 Kilogramme	.	Kgm	=	1,000	=	2·2046	,,
1 Hectogramme	.	Hgm	=	100	=	3·5274	ozs. av.
1 Dekagramme	.	Dgm	=	10	=	154·3236	grains.
1 Gramme .	.	Gm	=	1		15·4323564	,,
1 Decigramme	.	dgm	=	0·1	=	1·5432356	,,
1 Centigramme		cgm	=	0·01	=	0·1543235	,,
1 Milligramme	.	mgm	=	0·001	=	0·0154323	,,

459. Measures of capacity.

			Litres.			
1 Myrialitre	. Ml	=	10,000	=	2199·76	Impl gall.
1 Kilolitre	Kl	=	1,000	=	219·976	,, ,,
1 Hectolitre	Hl	=	100	=	21·9976	,, ,,
1 Dekalitre	Dl	=	10	=	1·1997	,, ,,
Litre .	L	=	1	=	35·196	Imp. Fl.ozs.
1 Decilitre	dl	=	0·1	=	3·5196	,, ,,
1 Centilitre	. cl	=	0 01	=	0·3519	,, ,,
1 Millilitre or cubic Centimetre	(mil) (or) (c c.)	=	0 001	=	0 0351 / 16·95	,, ,, / minims nearly.

460. Factors for conversion, formulæ, etc.

1 cubic centimetre of water at 4°C. weighs 1 gramme

		Multiply by
To convert	grammes into grains . .	15·4323564
,, ,,	,, ,, ounces, avoir .	0·035274
,, ,,	ounces into grammes . .	28·349
,, ,,	kilogrammes into pounds . .	2·20461
,, ,,	grains into grammes . .	0 06479
,, ,,	Troy ounces into grammes . .	31·104
,, ,,	cubic centimetres into Imperial fluid ounces .	0·03519
,, ,,	litres into Imperial fluid ounces .	35·196
,, ,,	Imp fluid ounces into cubic centimetres	28·42
,, ,,	pints into litres	0·5679
,, ,,	metres into inches . . .	39·370113
,, ,,	inches into metres . . .	0·0254
,, ,,	cubic feet into gallons . . .	6·23053
,, ,,	gallons into cubic feet . . .	0·1605

One pound avoirdupois = 7,000 grains = 453·59 grammes.

Superficial Space.

Area of Rectangle and Square—The length multiplied by the breadth.

Area of Rhombus or Rhomboid (in which the opposite sides are parallel)—The base multiplied by the perpendicular height

Area of Trapezoid—Half the sum of the two parallel sides multiplied by the width.

Area of Triangle—Half the product of base and height.

Area of Regular Polygon—The sum of the sides (perimeter) multiplied by half the perpendicular (drawn from the centre to the middle point of any side).

Area of Parabola—The base multiplied by two-thirds of the height.

Area of Circle—Square of diameter multiplied by ·7854 or square of radius multiplied by 3·1416

Area of Ellipse—The product of the long and short diameters multiplied by ·7854.

Area of Segment of a Circle—The cube of the height divided by twice the length of the chord added to two-thirds of the product of chord and height. *Note*: When the segment is greater than a semi-circle, find the area of the circle and deduct the area of the smaller segment.

Area of Sector of a Circle—Half the product of the arc multiplied by the radius

Area of Sphere—Diameter squared, multiplied by 3·1416, or four times square of radius multiplied by 3·1416

Cubic Space.

Volume of Cube or Rectangular Room—The length multiplied by the breadth multiplied by the height.

Volume of Prism—Area of base multiplied by height.

Volume of Cylinder—Area of base multiplied by height.

Volume of Cone or Pyramid—The area of base multiplied by one-third of the perpendicular height.

Volume of Dome (Segment of a Sphere)—Area of base multiplied by two-thirds of the height.

Volume of Sphere—Cube of diameter multiplied by ·5236 or four-thirds square of radius multiplied by 3·1416.

Volume of Wedge—Area of base multiplied by half of the perpendicular height.

Volume of Frustum of Cone or Pyramid—The sum of the areas of the two ends of the frustum and the square root of their product, multiplied by one-third of the height of the frustum.

The cubical capacity of a marquee used as a Hospital Ward may be formed by dividing it into (*a*) Body—a solid rectangle with a half cylinder at each end. (*b*) Roof—a solid triangle and two half cones.

Percentage solutions.

461. Quantity of dry measure required :—

Percentage.	Parts.	In 1 fl. dram.	In 1 fl. oz.	In 1 pint.
	1 in—	Grains	Grains.	Grains.
1	100	0·547	4 375	87·5
2	50	1·094	8 750	175·0
2½	40	1·367	10·937	218·75
3	33·33	1·640	13 125	262·5
4	25	2·187	17·500	350·0
5	20	2 734	21·875	437·5
6	16·66	3 281	26·250	525·0
7	14 28	3·828	30·625	612·5
8	12·5	4·375	35·000	700·0
9	11 11	4·922	39·375	787·5
10	10	5·468	43·750	875·0

The above table is based upon the official method for making a one per cent. solution, *i.e.*, one grain of solid in 100 grain measures of water, which at 16·7°C. equals 109·7143 minims (usually taken as 110 minims).

462. Quantity of fluid measure required :—

Percentage.	In 1 fl. oz.	In 1 pint.			In 1 gallon.		
	Minims.	Oz.	dr.	min.	Oz.	dr.	min.
1	4·8	0	1	36	1	4	48
2	9·6	0	3	12	3	1	36
2½	12·0	0	4	0	4	0	0
3	14·4	0	4	48	4	6	24
4	19·2	0	6	24	6	3	12
5	24·0	1	0	0	8	0	0
6	28·8	1	1	36	9	4	48
7	33·6	1	3	12	11	1	36
8	38·4	1	4	48	12	6	24
9	43·2	1	6	24	14	3	12
10	48·0	2	0	0	16	0	0

Thermometers.

(Fahrenheit and Centigrade.)

463. This table shows the relationship between these two thermometric scales at certain temperatures.

To convert degrees F. into degrees C., deduct 32, multiply by 5 and divide by 9.

To convert degrees C. into degrees F., multiply by 9, divide by 5 and add 32.

F.	C.	F.	C.	F.	C.	F.	C.
212	100	100	37·8	88	31·1	60	15·6
200	93·3	99·5	37·5	86	30·0	58	14·4
150	65·6	99	37·2	84	28·9	56	13·3
112	44·4	98·4	36·9	82	27·8	54	12·2
110	43·3	98	36·7	80	26·7	52	11·1
108	42·2	97·5	36·4	78	25·6	50	10·0
106	41·1	97	36·1	76	24·4	48	8·8
105	40·6	96·5	35·8	74	23·3	46	7·7
104	40·0	96	35·6	72	22·2	44	6·6
103	39·4	95·5	35·3	70	21·1	42	5·5
102	38·9	95	35·0	68	20·0	40	4·4
101·5	38·6	94	34·4	66	18·9	38	3·3
101	38·3	92	33·3	64	17·8	36	2·2
100·5	38·1	90	32·2	62	16·7	32	0

Indian Weights.

464. Indian weights vary slightly in different parts of the country but the following are those most universally used :—

5 Tolas	=	1 Chittak.
8 Chittaks	=	1 lb,
16 Chittaks	=	1 Seer.
40 Seers	=	1 Maund.

Indian coins may be employed as approximate weights ; as coined however there is a permissible variation amounting at the most to 1 per cent., and after circulation further variation may occur from wear.

1 Rupee weighs 180 grains or 1 Tola.

8-Anna silver piece weighs 90 grains.

4-Anna cupro-silver piece weighs 45 grains.

2-Anna cupro-silver piece weighs 22·5 grains.

2-Anna cupro-nickel piece weighs 90 grains.

1-Anna cupro-nickel piece weighs 60 grains.

1-Pice bronze piece weighs 75 grains.

½-Pice bronze piece weighs 37·5 grains.

1-Pie bronze piece weighs 25 grains.

465. Measurements.

1-Pice bronze piece measures 1 inch in diameter.

2-Anna cupro-nickel piece measures 1 inch from rounded corner to rounded corner. The *least* diameter of this coin is 21 millimetres, and this is also the *maximum* diameter of the 1-Anna cupro-nickel piece with the scolloped edge. Both coins are useful in furnishing the metric and English standards of measurement.

A one rupee note measures approximately 5 inches across. The Field Medical Card, A. F. W-3118 measures roughly 8⅛ inches by 5½ inches.

An ordinary gentleman's visiting card measures 3 by 1½ inches.

466. Rough data.

	lbs.
A cubic foot of—	
Fresh water weighs	62 5
Salt water „	63·5
Steel „	489·6
Loose earth „	95 0 approx.
Clay „	125·0 „

Abbreviated Telegraphic Addresses.

467. Subject to alterations which may be made from time to time the following abreviated telegraphic addresses have been registered in India :—

Director, Medical Services in India .	=	Medical, India.
„ „ „ in the field	=	Medical.[1]
D. D. M. S. Northern Command .	=	Northmed.
D. D. M S. Southern Command	=	Southmed.
D. D. M S/A D M S Division .	=	Divmed
A D. M. S. Brigade . .	=	Brigmed.
D. A. D M. S (Mobilization) . .	=	Medmob.
D. A. D. M. S (Sanitary) .	=	Medsan.
O. C. British General Hospital .	=	Brigenosp.
O C. Indian General Hospital .	=	Ingenosp.
O. C. Frontier War Hospital . .	=	Frontwasp.
O. C. British Station Hospital . .	=	Bristhosp
O. C. Indian Station Hospital . .	=	Insthosp
O. C. British Convalescent Section .	=	Consecbrit
O. C. Indian Convalescent Section .	=	Consecind.
O. in C. Central Dermatological Laboratory	=	Dermlab.
O. C. British Malaria Convalescent Depot	=	Malarcon.
Senior Medical Officer . . .	=	Esemo.

Antiseptics.

468. The following antiseptics will kill *B. coli communis* in $2\frac{1}{2}$ minutes under laboratory conditions, in the strengths stated[2] .—

Acidum Benzoicum . .	0·2	per cent.
Acidum Carbolicum . .	1·1	,,
Acidum Oxalicum . .	0·5	,,
Acidum Picricum . .	0·25	,,
Acidum Salicylicum . .	0·1	,,
Acidum Sulphuricum . .	0·5	,,
Alcohol	70·0	,,
Argenti nitras . . .	1	in 2,000.
Chlorine	1	in 75,000.
Creosote	1	in 300.
Formaldehyde . . .	2·0	per cent. (=5% Formalin).
Hydrargyri cyanidum .	1	in 2,500.
,, iodidum . .	1	in 100,000.
,, perchloridum .	1	in 100,000.
Iodine	1	in 50,000
Liquor Cresolis saponatus .	0·5	per cent.
Potassium permanganas .	1	in 2,000.
Thymol	1	in 1,500.

Atomic Weights.

469. The following are the International, 1915, Atomic Weights of the various elements mentioned in this book :—

Aluminium	27·1
Arsnenic	74·96
Calcium	40·07
Carbon	12·00
Chlorine	35·46
Copper	63·57
Hydrogen	1·008

Iodine	126·92
Iron	55·84
Lead	207·1
Magnesium	24·32
Manganese	54·93
Mercury	200·6
Nitrogen	14·01
Oxygen	16 00
Phosphorus	31·04
Potassium	39·1
Silver	107·88
Sodium	23·0
Sulphur	32 07
Zinc	65·37

Rainfalls.

470. The following are the average annual rainfalls at certain stations on the Frontier and the Lines of Communication. The month with maximum rainfall and average amount are also shown.

Station.	Annual Normal.	Worst month.	Quantity.
Ambala	30·63	July	9·64
Attock	19·48	August	4·07
Bannu	12·10	July	2·68
Bhamo	72·72	"	17·28
Chaman	7·12	March	1·70
Cherut	28·00	August	4 50
Chitral	15·42	March	3 81
Dibrugarh	109·06	July	20·64
Dera Ismail Khan	9·32	"	2·02
Drosh	16·76	April	4·17
Fort Lockhart	31·02	July	5 37
Fort Sandeman	10·05	"	2·20

Station	Annual Normal	Worst Month	Quantity
Gangtok	135 11	July	24 90
Gilgit	4·91	April	1 05
Hangu	26 60	August	5 66
Hindubagh	6 84	January	1 77
Jhelum	25 69	July	6 62
Kabul	12 89	March	4 05
Kila Saifulla	6 58	July	1 69
Kohat	18 27	,,	3 32
Lahore	19 58	,,	5 49
Landi Kotal	17·49	March	3 48
Loralai	8 43	July	1 54
Malakand	40·34	August	10·27
Manipur	61·82	July	11 12
Mardan	18 38	August	4 37
Multan	6 92	July	2 04
Myitkyina	78 91	,,	19 35
Nowshera	14 24	August	2 51
Peshawar	13 42	March	2 13
Pishin	8 11	,,	2 17
Quetta	10 02	February	1 99
Rawalpindi	34 06	August	8 82
Robat	3 76	.	...
Sadiya	103·19	July	20 05
Shelabagh	12 24	March	3 24
Shillong	86 05	August	16·35
Sialkot	30 69	,,	9·38
Tank	9 24	July	2 72
Thal	16 47	,,	3 63
Tochi (Datta Khel)	10 57	March	2 59
Wano	12 23	,,	3·99

How to make Charcoal.

471. A pit about 5 feet diameter and 3 feet deep is dug and a fire of wood made in it and fed until the pit is just full of fuel. As the fire burns, the hot embers sink to the bottom of the pit and fuel should be piled on and kept burning fiercely until the pit seems almost full of embers, when sufficient fuel should be added to raise the heap about a foot above the level of the ground. The

earth dug out of the pit should now be shovelled back over the burning mass and the whole left to cool for 24 hours, when the pit will be found nearly full of charcoal.[4]

How to Waterproof.

472. The waterproofing of textiles can be effected by painting with hot weak glue and $2\frac{1}{2}$ per cent solution of alum, or by alternate dipping in an emulsion of soap and a solution of alum.[5]

How to prepare Eusol.

473. Eusol if not made with reliable bleaching powder may be worse than useless as a germ deterrent. The following formulæ and instructions are recommended :—

Stock solution A.

Boric acid	Ozs. 6.
Clear water (preferably boiled) . . .	Gals. 2.

Stock solution B.

Standardized bleach solution (1·28%) . .	Gal. 1.

Keep in a stoppered jar or in stoppered bottles in a cupboard or in the dark. For use —add 1 part of Solution B to 2 parts of Solution A The object of boiling the water is to precipitate the temporary hardness. The stock solutions, if kept as directed, will remain practically unaltered for several months. Solution B can be re-tested and standardized at any Sanitary Section.

Distinguishing Flags for Medical Units.

474. Union Jack, 1 foot 2 inches broad by 2 feet 4 inches long, and Geneva Flag, 1 foot 9 inches broad by 2 feet 4 inches long, displayed horizontally side by side. These can be made from tin and painted.

REFERENCES.

[1] F. S. Regs. I, 16 (1).

[2] Martindale and Westcott, Extra Pharmacopœia 1915, p. 965.

[3] Memoirs of the Indian Meteorological Department, Vol. 22, part I, and Weather Reports

[4] Military Engineering, Part V, 86.

[5] Lelean; Sanitation in War, p. 25.

APPENDIX I.

EQUIPMENT OF A SANITARY SECTION.

Alum sulphate (in 1 lb tins)	lbs.	8
Army Fly Spray	galls	20
Axes, felling, curved helve		6
„ pick heads, 6½ lbs		16
„ helves maul 34½″		16
Badges Sanitary Police (for N C. Os & men)		24
Bleaching powder (to contain at least 25% chlorine)	lbs.	8
Brassards		103
Brooms, sweepers'		80
Buckets, galvanized iron		8
water G S canvas, I P (for tents)		8
Canvas water storage tanks (Royal Irish Fusilier pattern or a suitable substitute)		16
Chests, tool (Field ambulance pattern)		4
Chlorine apparatus		2
Clothing, F S additional articles		
Cordage, hemp, hawser 3 strand, white, prepared in oil, 1½″, in 4 lengths of 50 yards	yds	200
Disinfector, Thresh's portable		1
Equipment, personal of public followers		
Field Incinerators, complete (Meerut or Lelean type)		8
Flags, distinguishing, I P—		
Latrine, Indian		16
Poles, 12 ft I P		16
Water Supply—blue		4
red		4
white		4
Poles, 10 ft. I P		12
Gur	lbs	20
Holder Harriden fly sprayers		6
Hooks, bill		16
Kettles, camp oval, with covers		4
Knives, opening tins		4
Lamps, F S. pattern, 1916 (for tents)		8
Oil kerosene 125°F. fire test	galls	20
Pakhals (or 5 massaks in lieu)	pairs	2
Potassium permanganate (in 1 lb. tins)	lbs.	8
Rods, iron, (each 4′ 6″ long × ¾″ diameter)		160
Saponified Cresol	lbs	200
Screens, latrine		8
Shovels, G S		48
„ helves		48
Stool, camp		1
Sodium arsenite (coloured)	lbs.	10

Table, camp		1
Tents, I P complete 80 lbs (for British N C Os and men)		4
160 lbs (for menial establishment)		4
Tools, sets, containing—		
Adze, carpenter's		1
Chisel, socket 1″		1
Files, saw crosscut 8″		1
,, ,, hand 6″		1
,, ,, tenon		1
Gimlets, set of 3		1
Hammer, claw 24 ozs		1
Nails, French of sizes	lbs	2
Pincers, carpenter's	pairs	2
Saw, hand 20″		1
Sets, saw, hand		1
,, ,, pit		1
Screwdriver, G S 6″		1
Screws, of sizes	lbs	1
Tape, measuring, metallic woven 50 ft		1
Tubing, gas pipe lead—each 6 ft long, internal diameter $\frac{3}{8}$″	pieces	8
Yakdan, with padlock and keys		1

NOTE —As the above equipment will probably be revised, a list is given below of such additional equipment as has been used in Sanitary Sections in Egypt and Mesopotamia —

		Per Section.
Anvil, $\frac{1}{4}$ cwt		1
Axe, hand, Mark II		2
Barrows, stable		2
Bitumen	galls	4
Block, anvil, $\frac{1}{4}$ cwt		1
Bottles, narrow-mouth, [illegible]		4
,, water, enamelled, [illegible] carrying bleach solution)		12
Box, stationery, field, small, Mark V		1
Braces, ratchet posts 16″		1
,, ,, ,, 12″		1
,, ,, drills $\frac{1}{4}$-$\frac{7}{8}$″	set	1
Brooms, bass heads, tropical climate		20
,, ,, handles		20
Burette Mohr's with jet and stop cock 25 c c graduated to 1-10 c c		1
Calipers, inside 5″		2
,, outside 6″		2
Chisels, hand cold, $\frac{3}{4}$″ × 8″		8
,, ,, ,, cross cut $\frac{3}{8}$″ × 8″		2
Churn, Champion, 8 gallon (for mixing bleaching solution)		1
Files, flat, rough 12″		4
,, ,, smooth 12″		2
,, $\frac{1}{2}$-round, smooth 10″		4
,, square, smooth, 8″		2
Fluxite	lb	1
Foot prints 8″		2
Forks, hay, large		10
Gum		

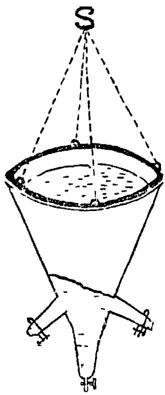
Hair clippers		2
Hammers, mason's, chisel point		1
Hose, canvas, 30 ft. length		16
„ prepared canvas 2" × 12 ft		16
Hydrochloric acid	lb.	1
Hyposulphite of soda	lb	1
Iron, soldering, tinman's, small		1
Irons, flat		2
Labels, bleach solution		
„ test solution		
Lamps, brazing 1 pint		2
„ hurricane		16
Level, spirit adjustable		1
Mallet, tinman's, small		1
Mugs, enamelled white		6
Pakhals, mule, for bleach solution	pairs	3
Petrol	galls	2
Pipettes, graduated 10 c c. in $\frac{1}{10}$ c c		2
Planes, smoothing		2
Pliers, side-cutting 8", Mark IV	pairs	1
Potassium iodide tabloids	lb.	1
Pots, watering, large		10
Pumps, lift and force, Mark IV		16
„ mechanical, Merryweather (Valiant) No 1 size		4
Punches, centre, 4"		2
Rakes, garden 15"		12
Rules, G S 4-fold, 2-ft		4
„ mason's, plumb, 2' 6"		1
Saw, compass (for making latrine seats)		2
Scales, ounce, 7½" beam, shallow brass pans 4" diameter, stamped weights		1
Screwdriver, G.S , 12"		4
Shears, tinman's snip, Mark, II		2
Solder, tinman's	lbs	6
Spanners, A A D. E $\frac{1}{4}''$, $\frac{3}{16}''$, $\frac{5}{16}''$, $\frac{7}{16}''$, $\frac{3}{8}''$, $\frac{1}{2}''$, $\frac{5}{8}''$, $\frac{3}{4}''$, $\frac{7}{8}''$, 1"	sets	2
„ adjustable 9"		4
Square, fitter's 8"		2
Stand, burette		1
Starch	lb	1
Stove, Primus, No 5 (1 burner) for making starch solution		1
Tanks, water, "Butt Gow" 80 galls.		4
„ „ 2,300 galls.		16
Taps, ¼" taper second and plug	set	1
Tins, mess D S. (for boiling starch)		1
Tools, screw-cutting, bolt and nut, Mark III, Chest C,	chest filled	1
„ „ „ iron and steel tube, chest ¼"-1½"	chest filled	1
„ „ „ iron and steel tube, chest 1¾"-3"	chest filled	1
Towels, local pattern		12
Trowels, bricklayers, 12"		4
„ „ pointing cross joint		1
„ „ stop		1
Vice, bench parallel		1
Wrenches, pipe, flat link, 1"-6"	No. 3	1

APPENDIX II.

Diagrams.

PLATE I.

FIG 1



JAPANESE ISHIJI FILTER.

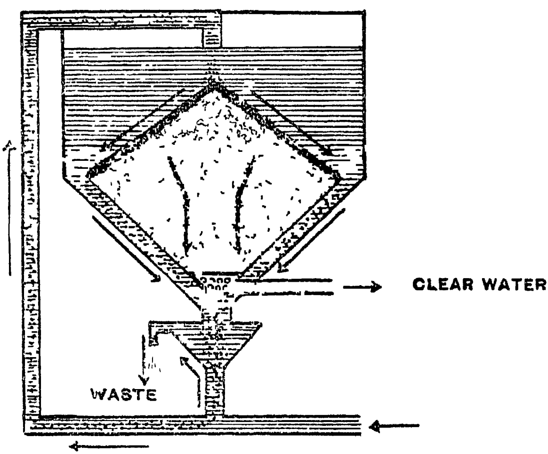


DIAGRAM OF A DRIFTING SAND FILTER.

FIG 2

PLATE 2

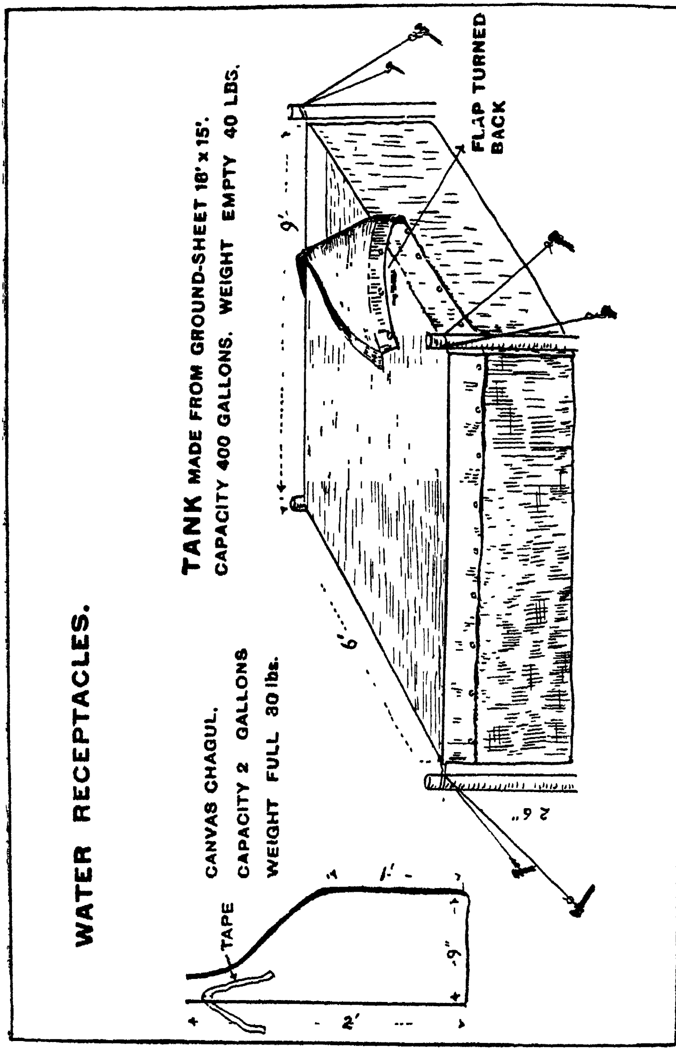
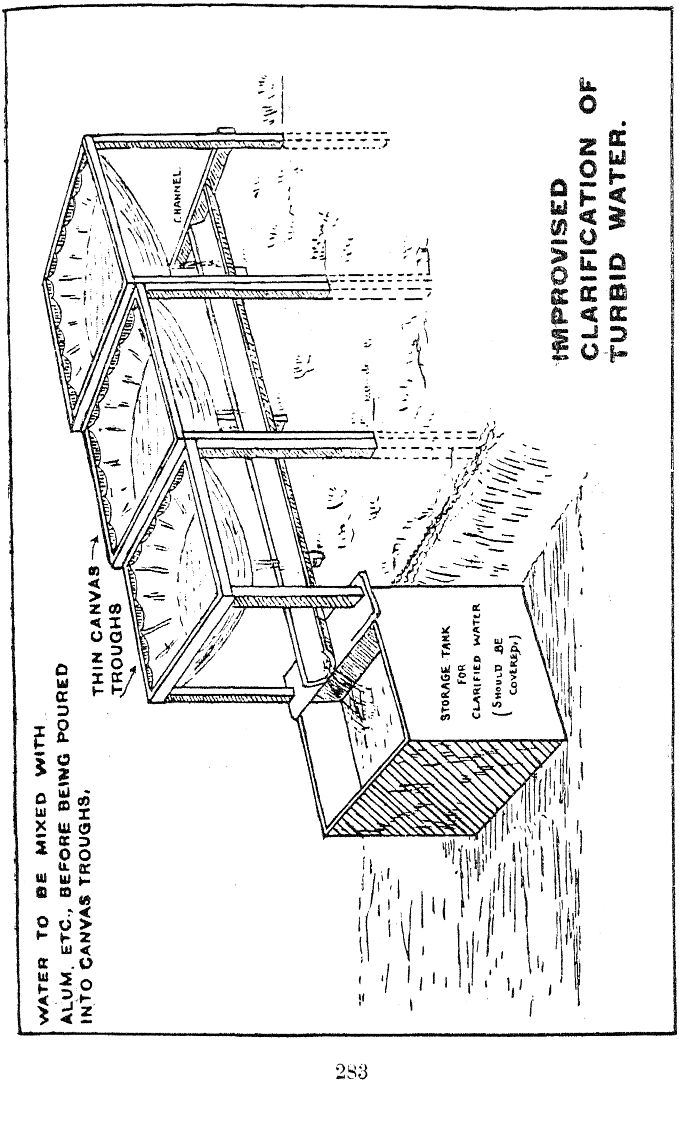

WATER RECEPTACLES.
TANK MADE FROM GROUND-SHEET 18' x 15'.
CAPACITY 400 GALLONS. WEIGHT EMPTY 40 LBS.
FLAP TURNED BACK
9'
6'
2' 6"
CANVAS CHAGUL.
CAPACITY 2 GALLONS
WEIGHT FULL 30 lbs.
TAPE
1'
9"
2'

PLATE 3



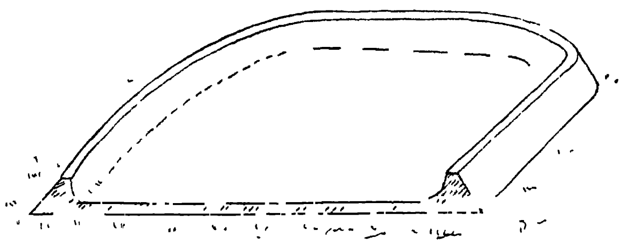
IMPROVISED CLARIFICATION OF TURBID WATER.

PLATE 4

FIG 1

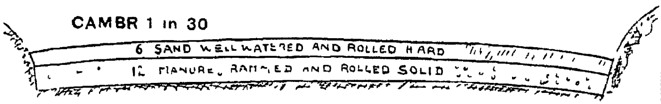
DRYING PLATFORM

FOR HORSE-MANURE



10' SQUARE
4" FLOOR
6" WALL

FOUNDATION TO BE SHAPED AND
ROLLED BEFORE TIPPING MANURE

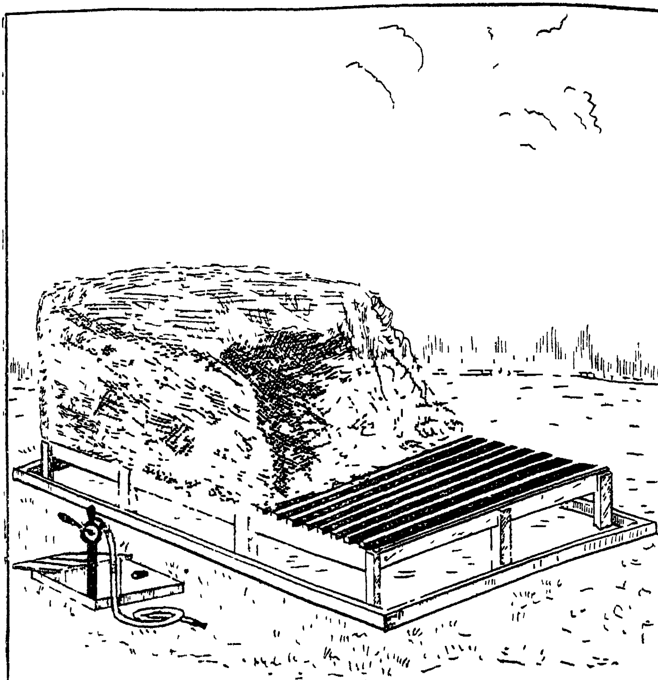


SECTION

CAMP ROAD CONSTRUCTED WITH HORSE-MANURE

FIG 2

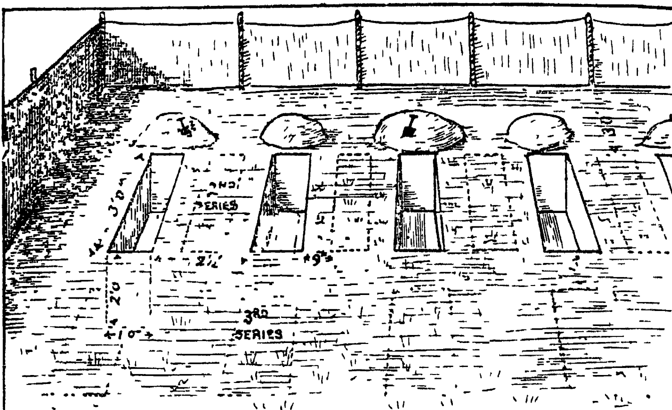
PLATE 5.



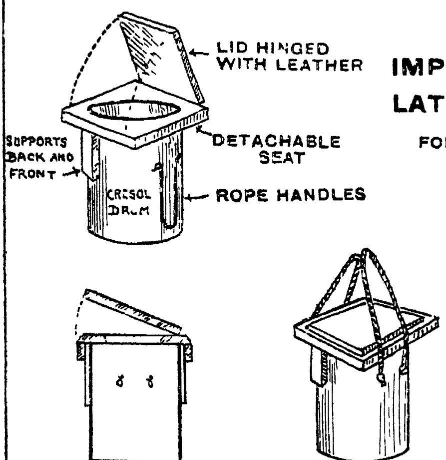
BLANCHARD'S METHOD OF FLY DESTRUCTION IN MANURE HEAPS.

PLATE 6

FIG 1



PLAN OF SHALLOW-TRENCH GROUND.



IMPROVISED LATRINE

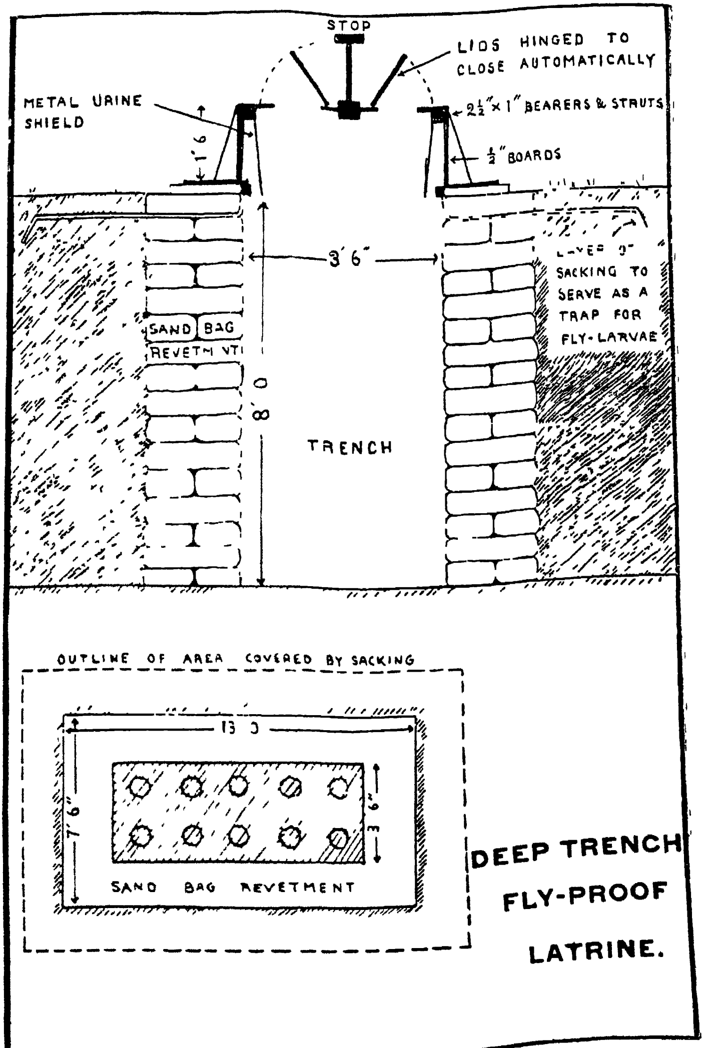
FOR THE TRENCHES

SECTION

READY FOR REMOVAL.

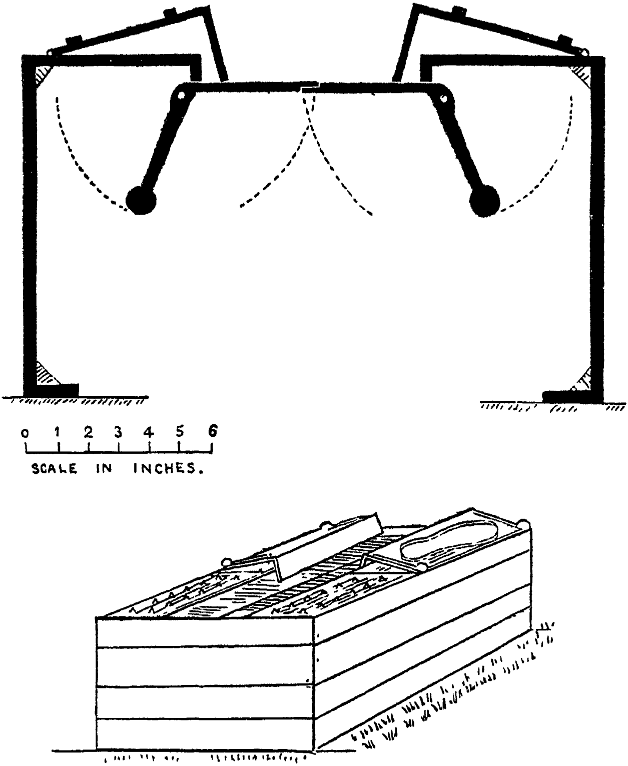
FIG 2

PLATE 7



DEEP TRENCH FLY-PROOF LATRINE.

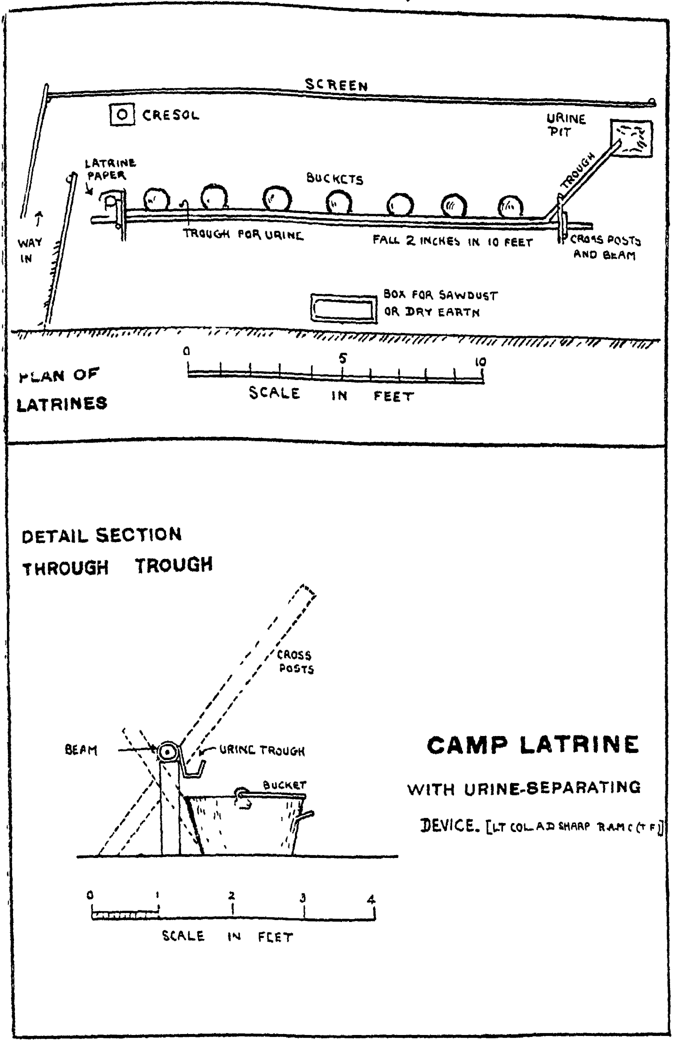
PLATE 8.



SELF-CLOSING LATRINE, INDIAN PATTERN.

INVENTED BY MAJOR W.R.J. SCROGGIE, C.M.G; I.M.S.

PLATE 9



CAMP LATRINE

WITH URINE-SEPARATING DEVICE. [LT COL. A D SHARP R.A.M.C. (T.F.)]

PLATE 10.

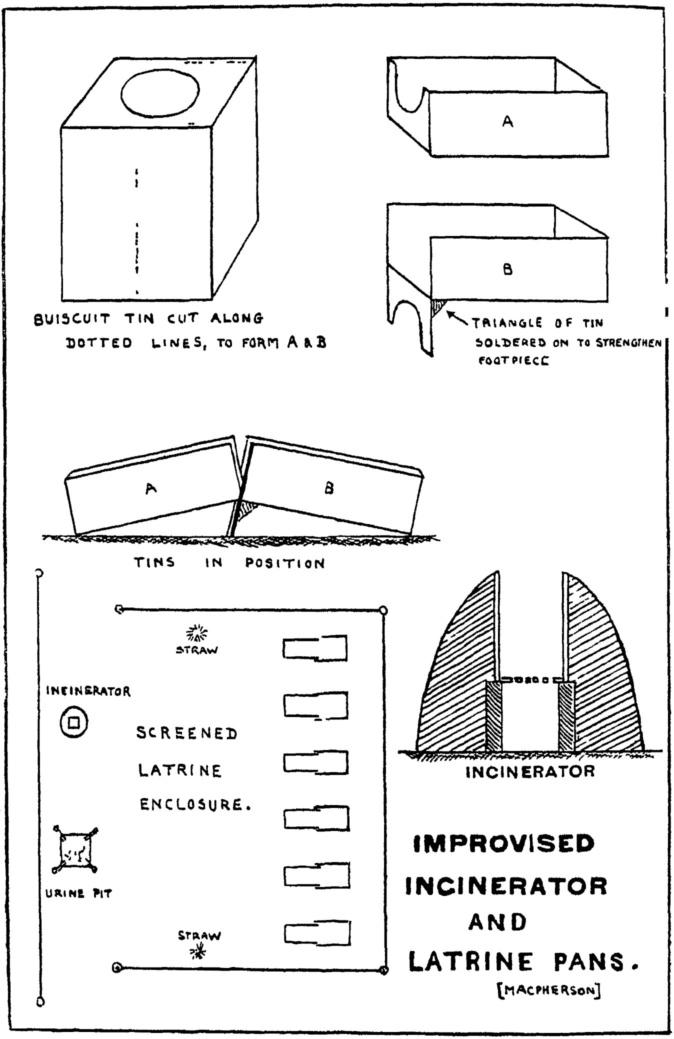

BUISCUIT TIN CUT ALONG DOTTED LINES, TO FORM A & B
A
B
TRIANGLE OF TIN SOLDERED ON TO STRENGTHEN FOOTPIECE
A
B
TINS IN POSITION
STRAW
INCINERATOR
SCREENED LATRINE ENCLOSURE.
URINE PIT
STRAW
INCINERATOR
IMPROVISED INCINERATOR AND LATRINE PANS.
[MACPHERSON]

PLATE II.

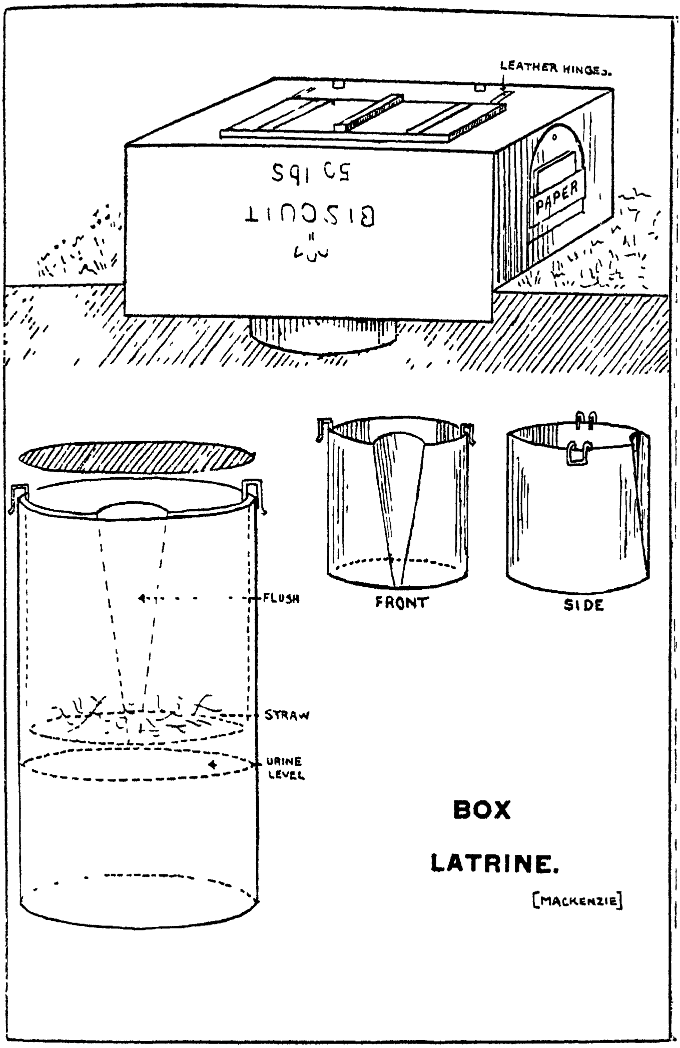

LEATHER HINGES.
PAPER
FLUSH
STRAW
URINE LEVEL
FRONT
SIDE
BOX
LATRINE.
[MACKENZIE]

PLATE 12.

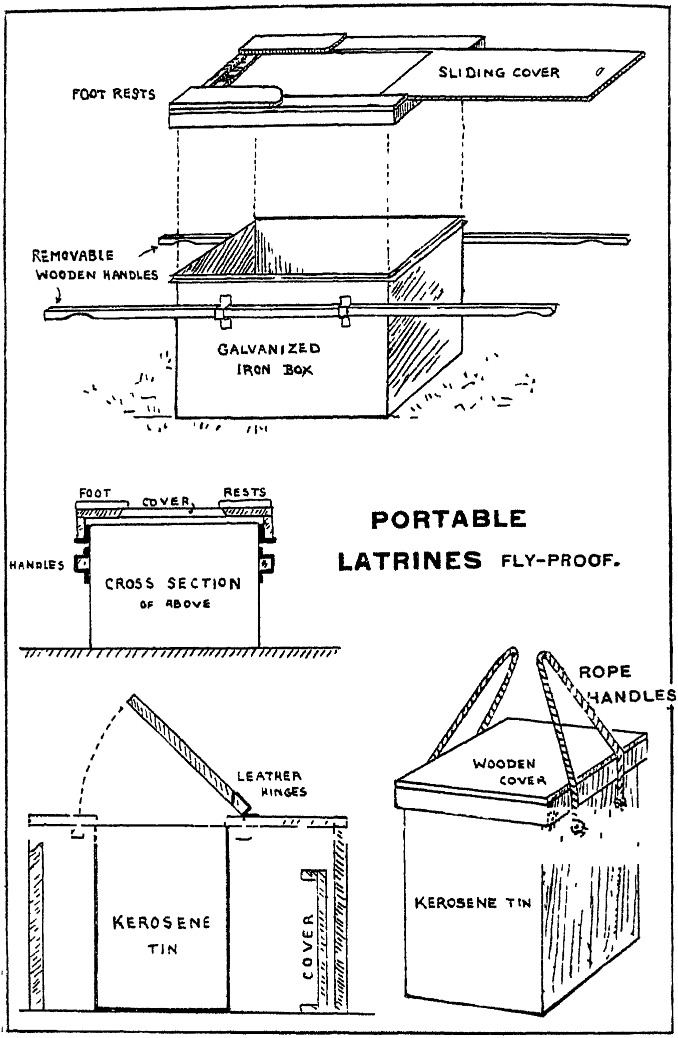
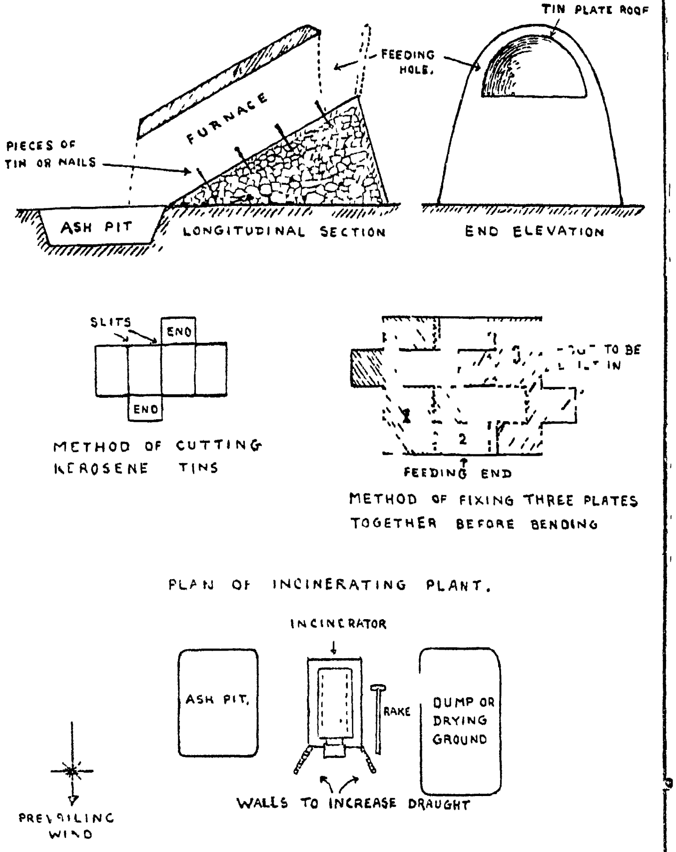
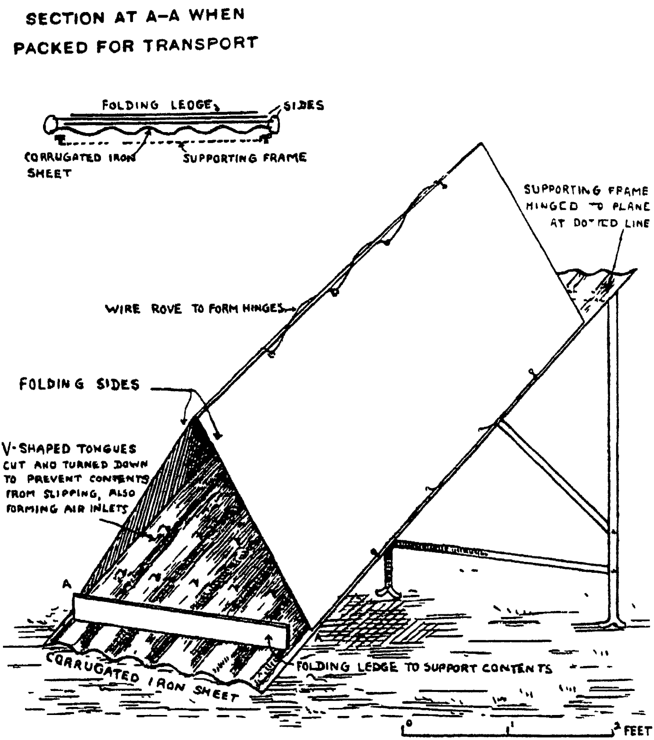

FOOT RESTS
SLIDING COVER
REMOVABLE WOODEN HANDLES
GALVANIZED IRON BOX
FOOT COVER RESTS
HANDLES
CROSS SECTION OF ABOVE
PORTABLE LATRINES FLY-PROOF.
ROPE HANDLES
WOODEN COVER
KEROSENE TIN
LEATHER HINGES
KEROSENE TIN
COVER

PLATE 13.



IMPROVISED INCLINED-PLANE INCINERATOR.

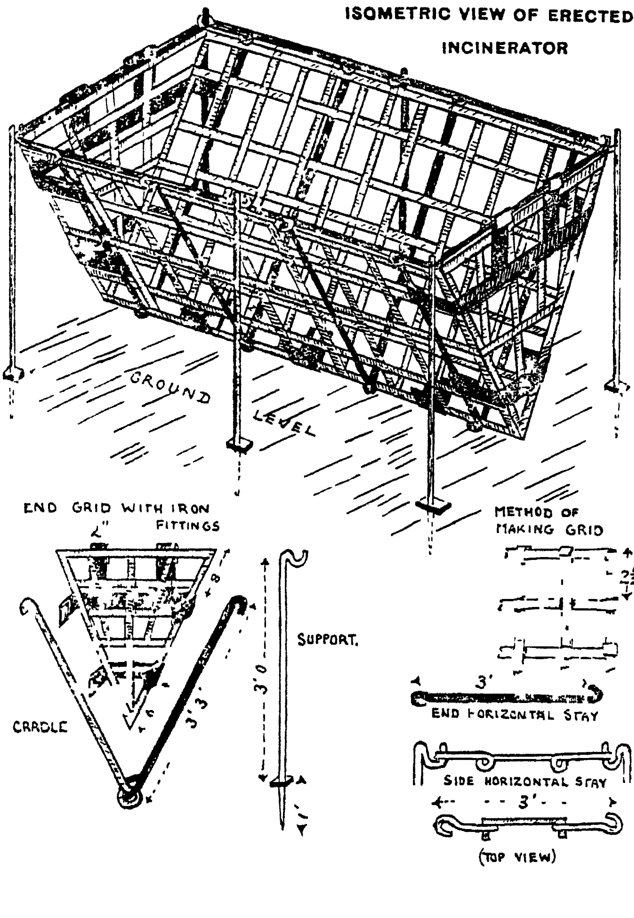
PLATE 14



PORTABLE INCLINED-PLANE

INCINERATOR.

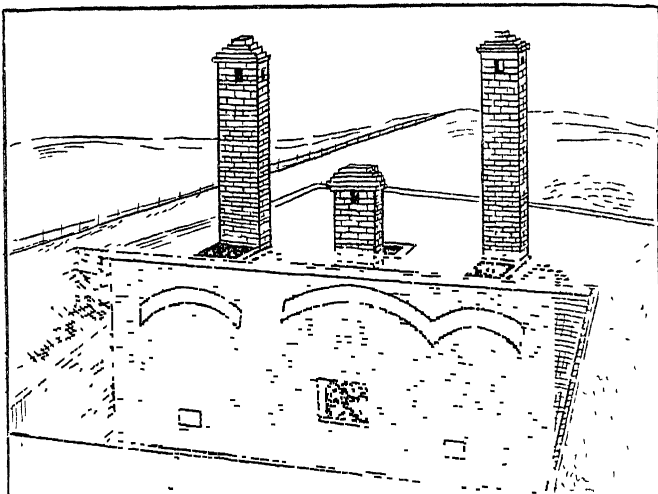
PLATE 15.

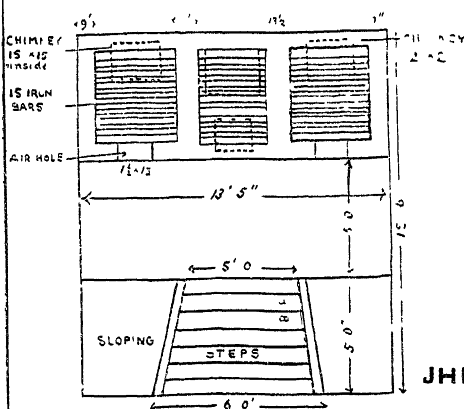


IMPROVISED OPEN INCINERATOR.

[SERJT SMITH No 13 SAN SECTION]

PLATE 16

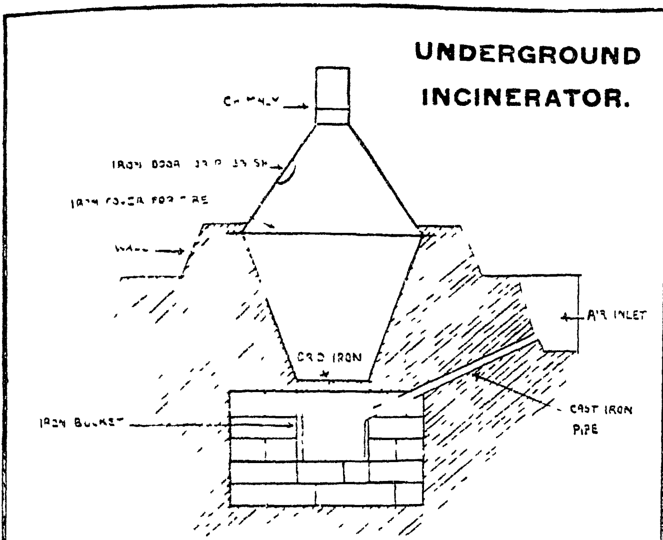




JHELUM PATTERN UNDERGROUND INCINERATOR

PLATE 17

FIG 1



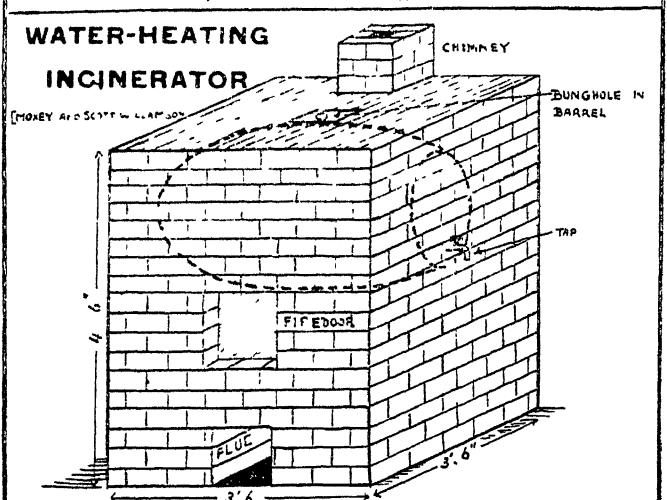
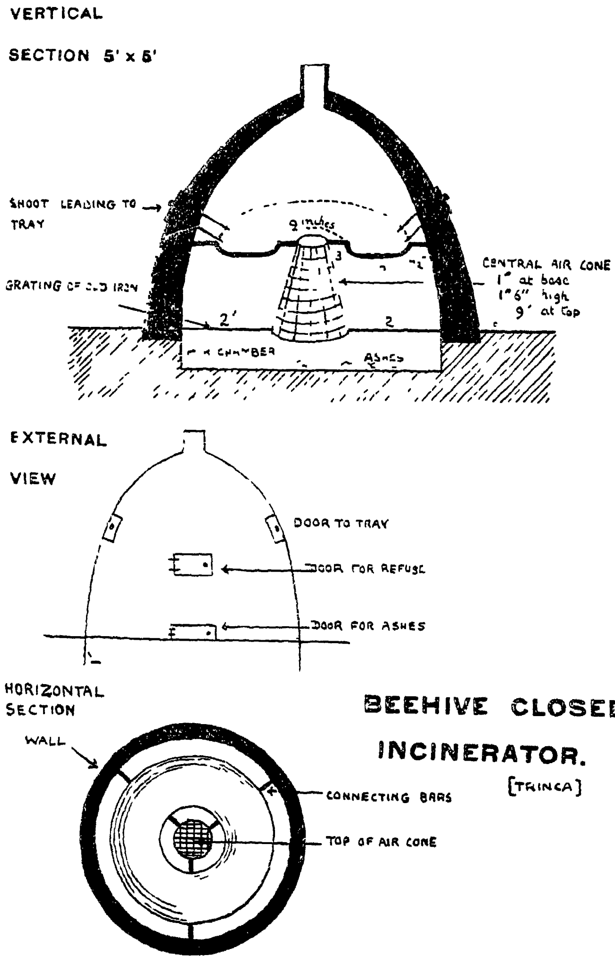


FIG 2

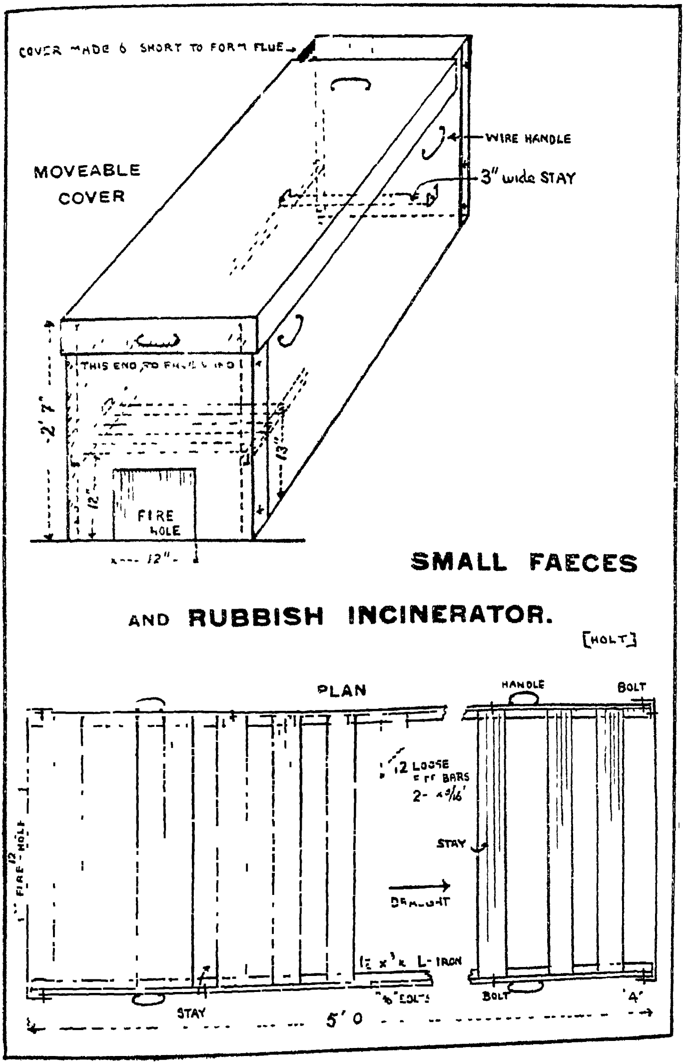
PLATE 18



BEEHIVE CLOSED INCINERATOR.

[TRINCA]

PLATE 19



SMALL FAECES AND RUBBISH INCINERATOR.

[HOLT]

PLATE 21.

FIG 1

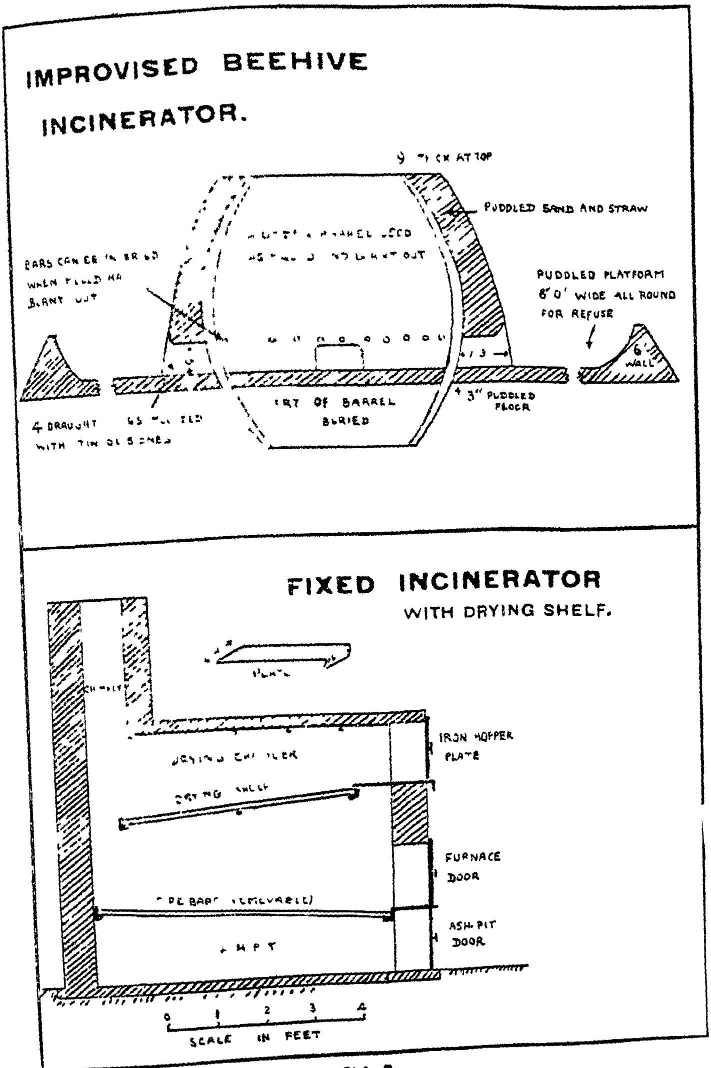
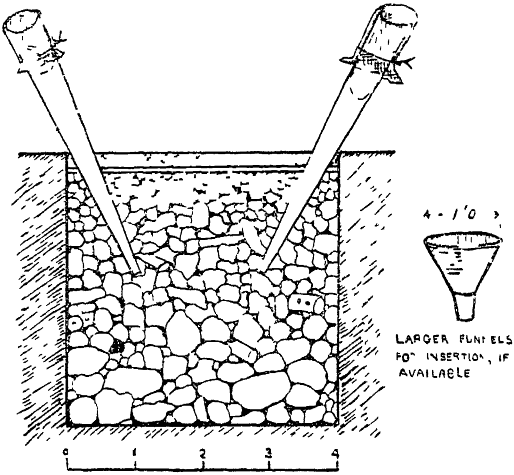


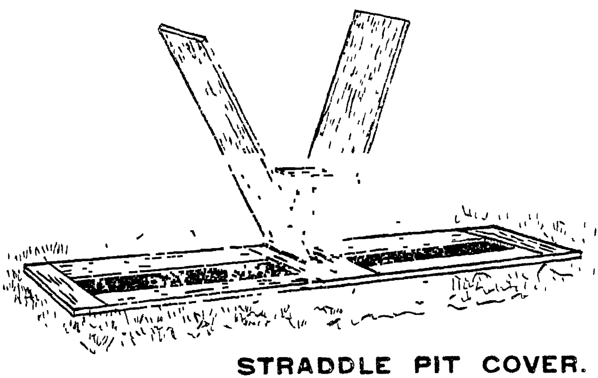
FIG 2.

PLATE 22.

FIG 1



URINE SOAKAGE PIT WITH FUNNELS



STRADDLE PIT COVER.

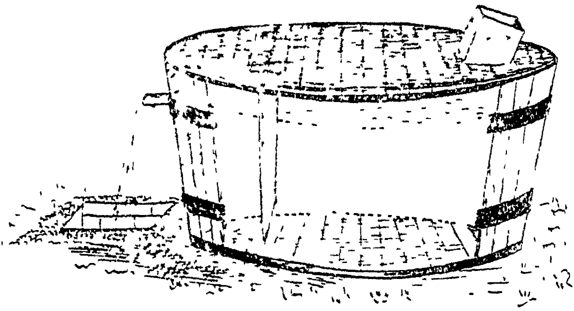
FIG 2

PLATE 23

FIG 1

IMPROVISED GREASE TRAP

[DAVEY]



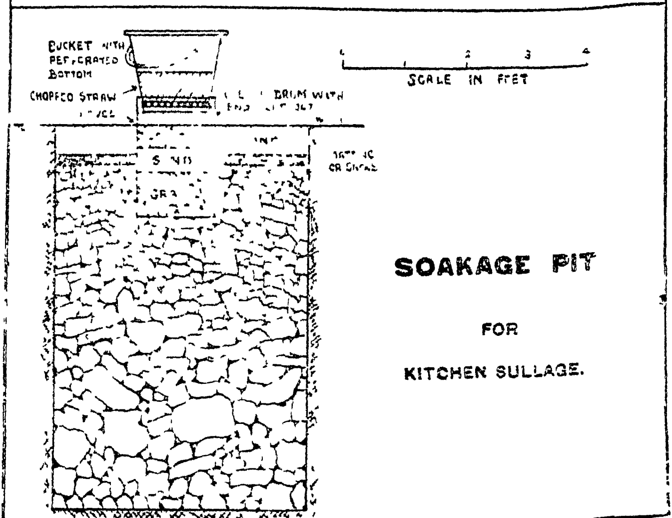
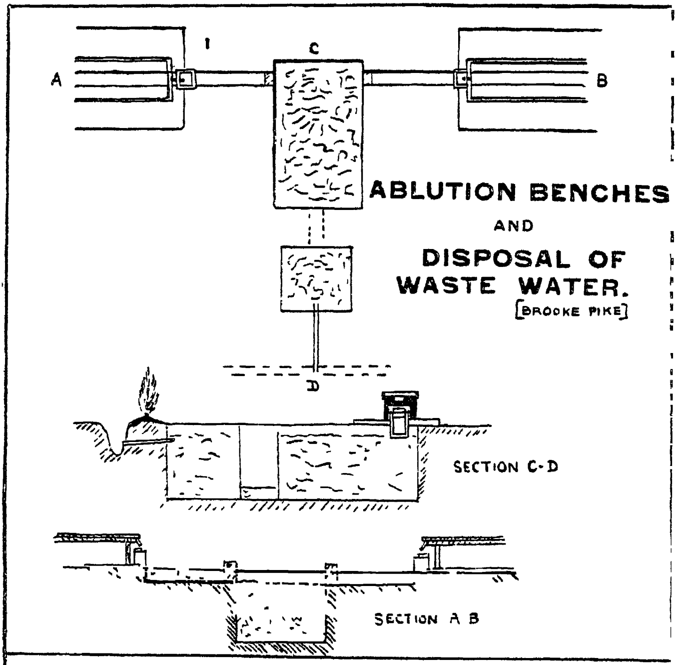


FIG 2

PLATE 24

FIG 1



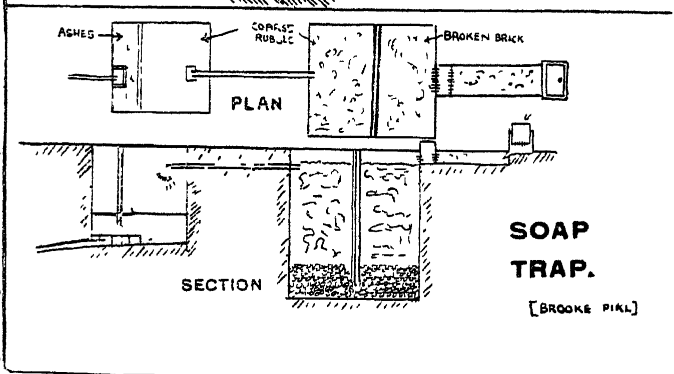
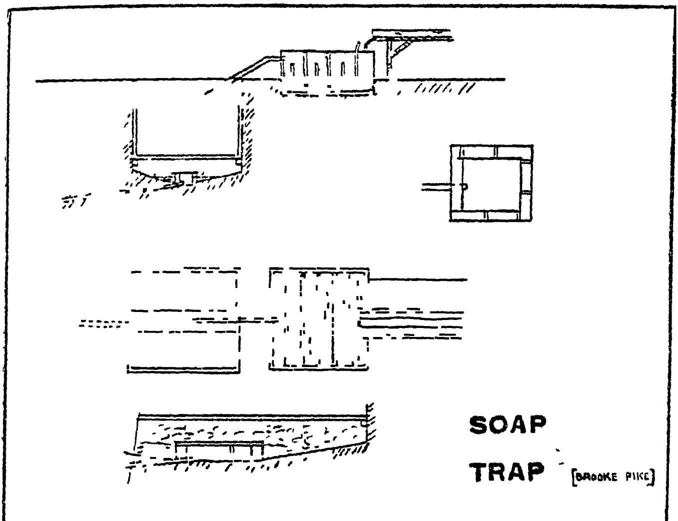


FIG. 2

PLATE 25

FIG 1



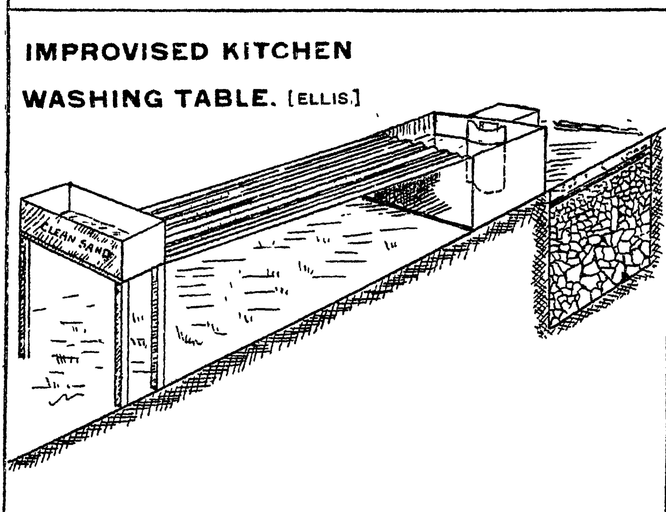
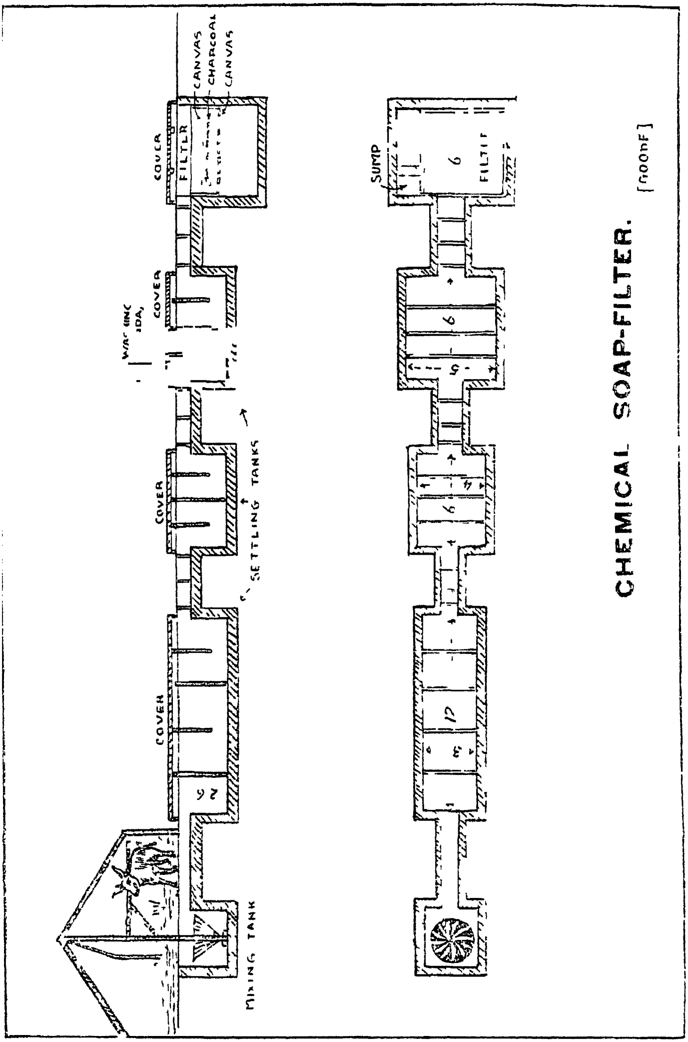


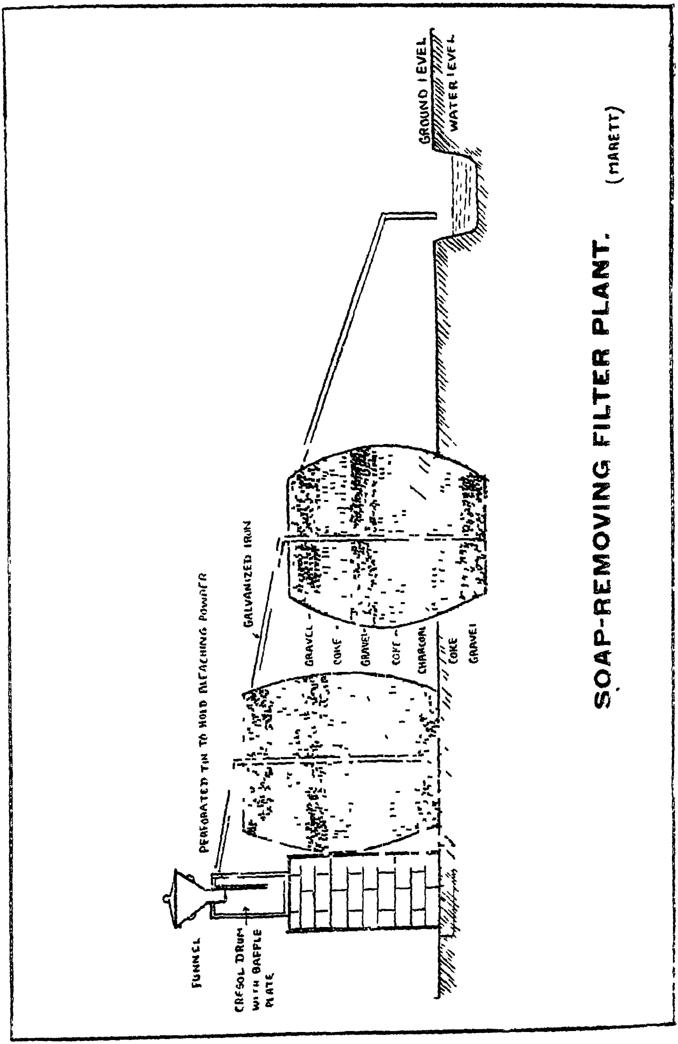
FIG 2

PLATE 26



CHEMICAL SOAP-FILTER.

PLATE 27



SOAP-REMOVING FILTER PLANT.

PLATE 28

FIG 1.

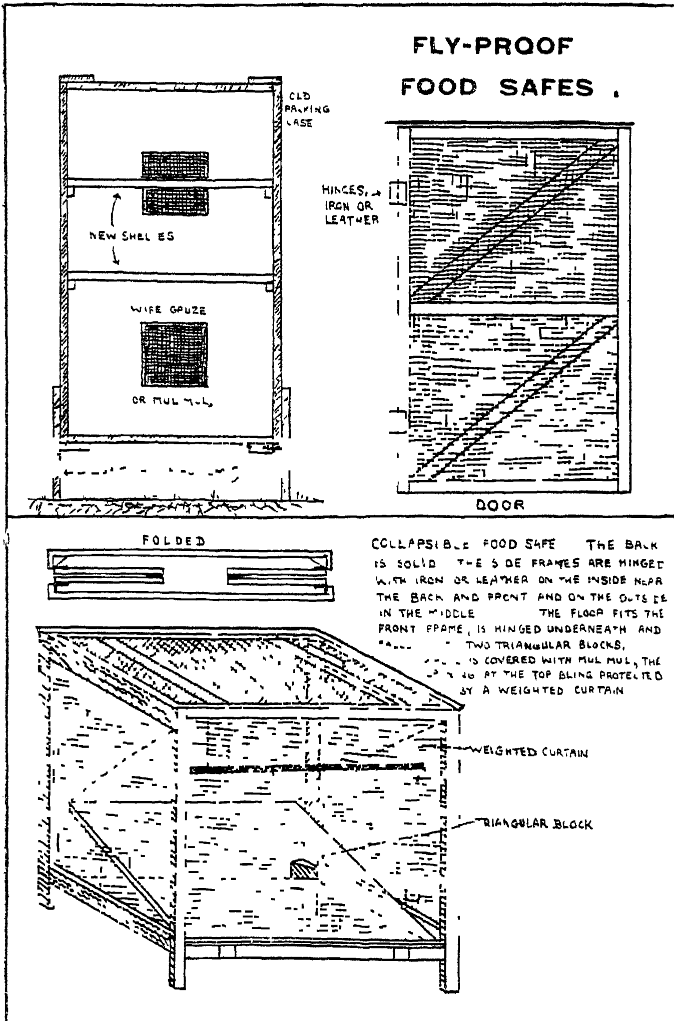


FIG 2

PLATE 29

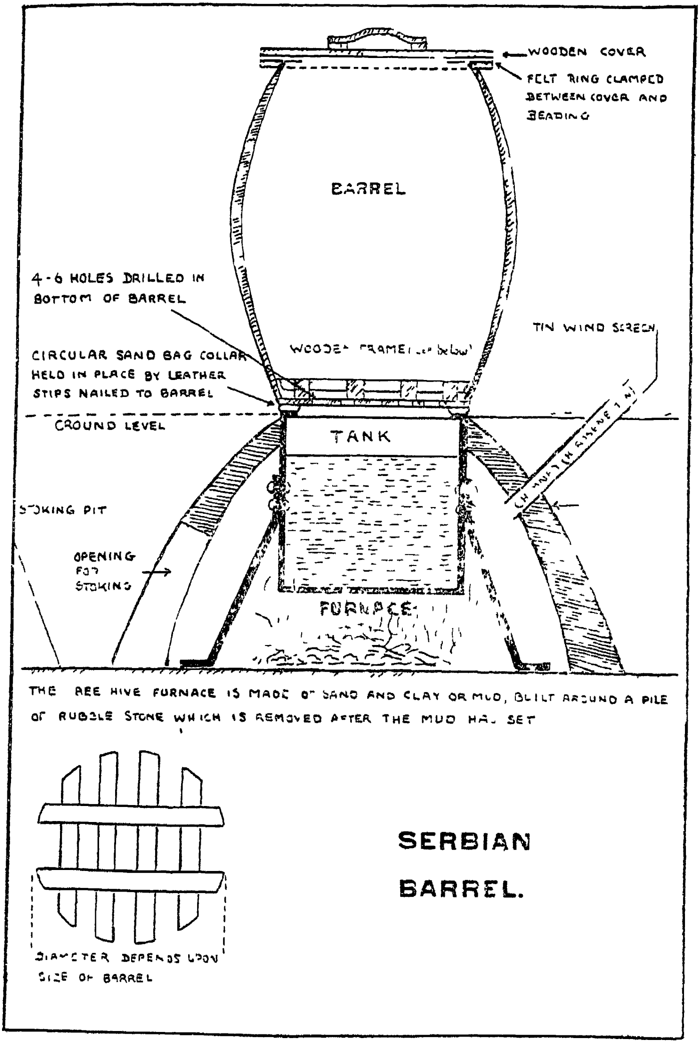
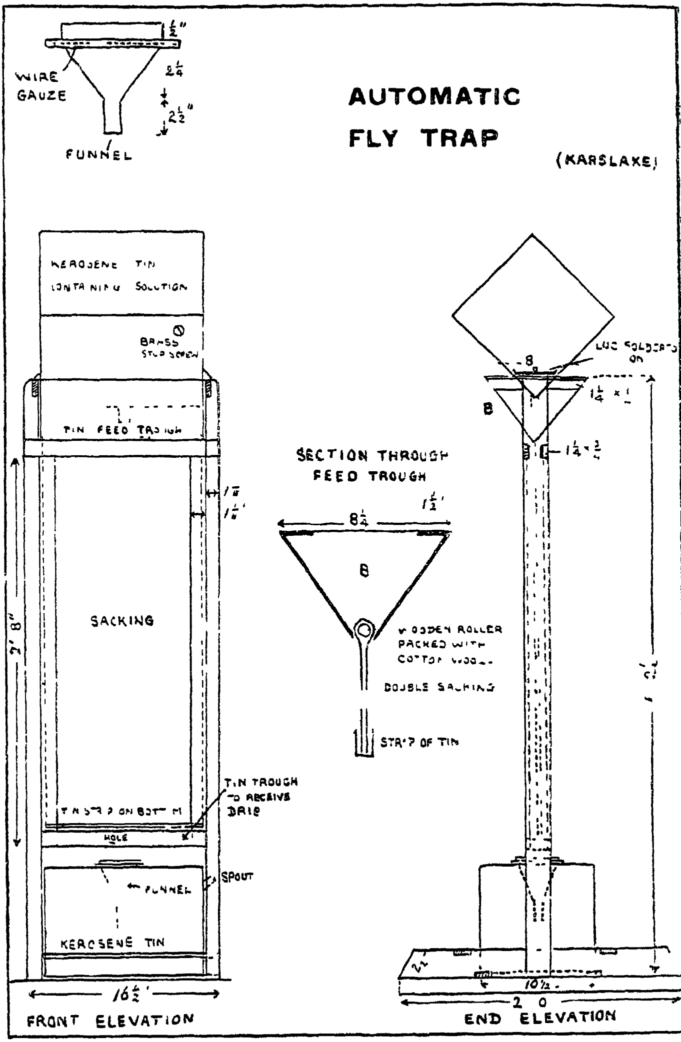

WOODEN COVER
FELT RING CLAMPED BETWEEN COVER AND BEADING
BARREL
4-6 HOLES DRILLED IN BOTTOM OF BARREL
CIRCULAR SAND BAG COLLAR HELD IN PLACE BY LEATHER STIPS NAILED TO BARREL
TIN WIND SCREEN
GROUND LEVEL
TANK
STOKING PIT
OPENING FOR STOKING
FURNACE
THE BEE HIVE FURNACE IS MADE OF SAND AND CLAY OR MUD, BUILT AROUND A PILE OF RUBBLE STONE WHICH IS REMOVED AFTER THE MUD HAS SET
DIAMETER DEPENDS UPON SIZE OF BARREL
SERBIAN BARREL.

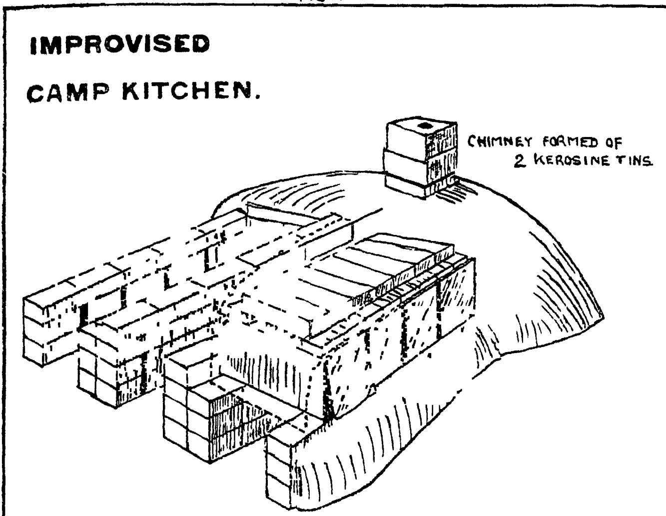
PLATE 32



AUTOMATIC
FLY TRAP
(KARSLAKE)
WIRE GAUZE
FUNNEL
KEROSENE TIN
CONTAINING SOLUTION
BRASS STOP SCREW
TIN FEED TROUGH
SACKING
TIN TROUGH TO RECEIVE DRIP
HOLE
SPOUT
FUNNEL
KEROSENE TIN
FRONT ELEVATION
SECTION THROUGH FEED TROUGH
WOODEN ROLLER PACKED WITH COTTON WOOL
DOUBLE SACKING
STRIP OF TIN
LUG SOLDERED ON
END ELEVATION

PLATE 33.

FIG I



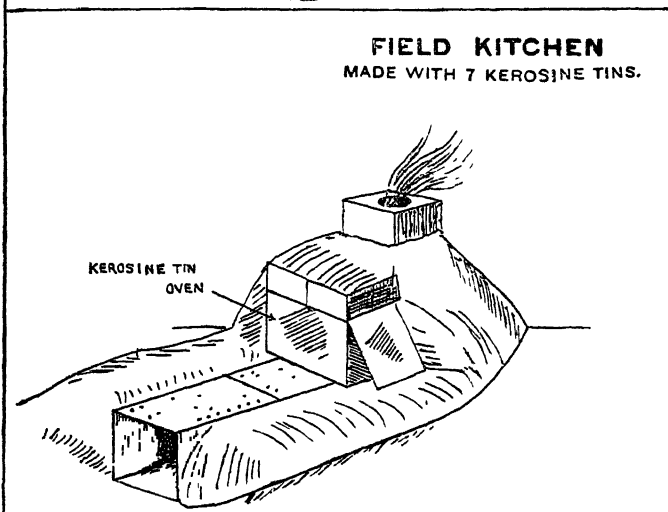


FIG 2.

PLATE 34

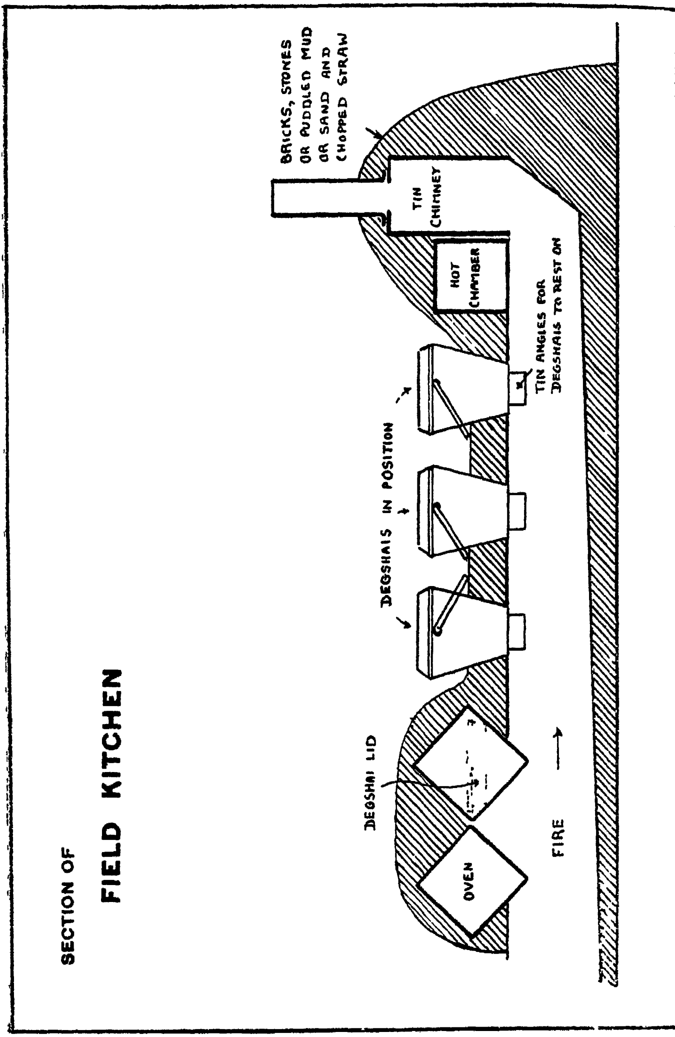
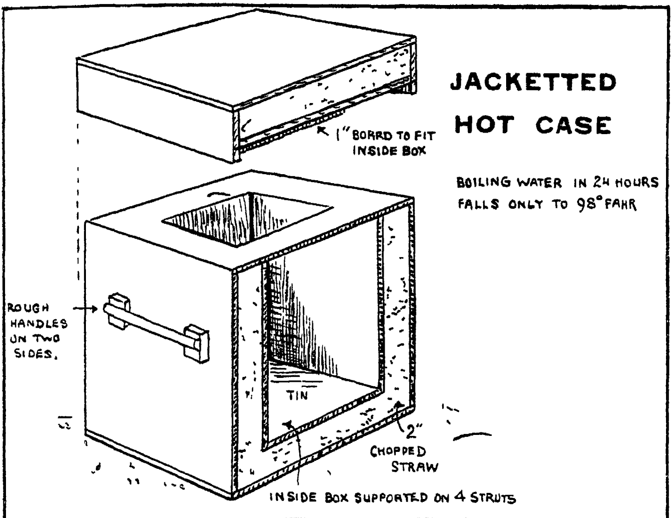

SECTION OF
FIELD KITCHEN
BRICKS, STONES
OR PUDDLED MUD
OR SAND AND
CHOPPED STRAW
TIN
CHIMNEY
HOT
CHAMBER
TIN ANGLES FOR
DEGSHAIS TO REST ON
DEGSHAIS IN POSITION
DEGSHAI LID
OVEN
FIRE

PLATE 35

FIG 1



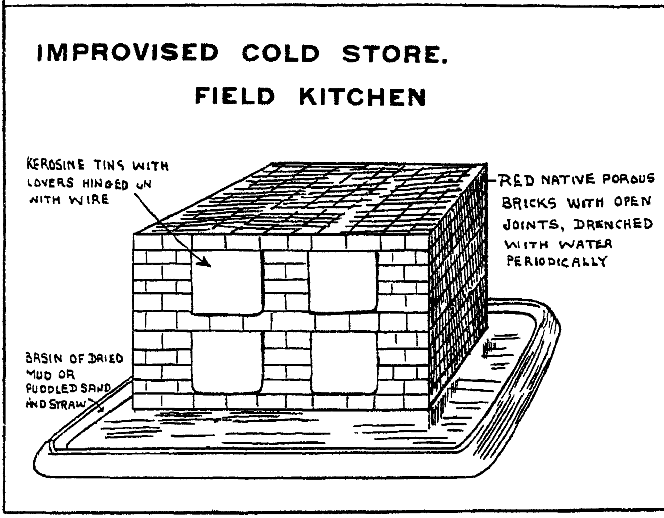


FIG 2

INDEX.

A

C

Section.

D

F

Section

G

H

I

J

K

L

M

N

O

P

Q

R

S

U

V

X

Y

Z

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
8, HASTINGS STREET